Needs-based Impact Assessment of Non-grid Rural Electrification: A Case of Eastern Cape

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Declaration

I, Nthabiseng Mohlakoana, submit this dissertation to the University of Cape Town in partial fulfilment of the requirements for the degree of the Master of Philosophy in Energy Studies. I declare that unless otherwise acknowledged, this is my original work and that it has not been submitted in this form or similar form for a degree at any University.

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Abstract

This thesis explores issues of electrification in the rural areas of the Eastern Cape. First, the set of issues explored are the rural areas electrification and general development background issues, taking the electrification from the early 1990s as the point of departure. Non-grid electrified, grid-electrified and non-electrified households in six Eastern Cape province areas were interviewed to gather information on their energy consumption. The research was undertaken to explore households' energy uses and to measure the impacts of having both grid and non-grid electricity. Socio-economic backgrounds of researched households are analysed to explore their contribution and influence to the types of energy sources used by households. By exploring socio-economic backgrounds, a picture is given of conditions that drive rural households to use different types of energy. By comparing the electrified and non-electrified households, the thesis explores and explains how the transition and switching from one fuel to the other is made within these households. Lastly, there is also an analysis of the way different electricity supply options used in the rural areas affect the way people use energy. This includes discussion as to whether different electricity supply options are accepted better than others and the reasons for this.

The conclusions drawn from the research done for this thesis shows that energy is a key component of rural development, yet energy demand (in terms of electricity use) in rural areas is low due to their underdeveloped nature. Even if modern energy is delivered to rural poor, households are often faced with very restricted income which severely limits energy use especially for thermal applications. These problems have to be addressed as a whole. In order to satisfy needs of people in rural areas, the provision of electricity, either grid or off-grid must go hand in hand with integrated local development through which poverty as a whole may be addressed.

Acknowledgments

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List of acronyms used

ANC	African National Congress
DC	Direct Current
DME	Department of Minerals and Energy
Eskom-Shell JV	Eskom-Shell Joint Venture
GEF	Global Environment Facility
LPG	Liquefied Petroleum Gas
NER	National Electricity Regulator
PV	Photovoltaic
RESCO	Rural Electricity Supply Company
SHS	Solar Home System
SMMEs	Small, Medium and Micro Enterprises
VAT	Value Added Tax
WEC	World Energy Council
Wp	Watt peak

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CHAPTER 1:
Energy Poverty in the Eastern Cape: An Introduction

> Everyday domestic life and activity in the home are inconceivable without energy. But poverty limits energy use, and so long as this situation continues, development will be hindered (DME 1998: 36).

1.1 Introduction

This thesis sets out to investigate the patterns of energy use of low-income households in one of the underdeveloped rural areas of South Africa. It analyses particularly the response of households to new and modern energy sources, as well as comparing the use of and response to different energy sources. The thesis argues that even though significant progress has been made towards developing rural areas in terms of electrification for poor households in particular, much still needs to be done. The thesis is not intended to be a critique of the current rural development strategy in South Africa, but to provide more insights to off-grid electrification on these areas. It looks at the energy needs of grid and non-grid rural household and assesses the impact of rural electrification in the Eastern Cape rural communities of South Africa.

Rural development is a cornerstone of the South African government's policy to redress overwhelming inequities since 1994 (ANC 1994). Numerous intervention strategies have been piloted and implemented particularly to resolve energy poverty. The Eskom-led[1] electrification programme provided more than 2.5 million households with electricity between 1994 and 1999. Together with local municipalities, Eskom increased the level of electrification from 36% in 1994 to 66% by the end of 1999. Throughout this electrification process, 80% of the electricity connections made were in the urban

[1] Eskom is the utility supplying 95% of all the electricity used in the country. This electricity is sold to industrial, mining, commercial, agricultural, residential customers and redistributors (municipalities).

areas. In rural areas, only 46% of households were connected to the national grid by 1999 (Eskom 1999: 18).

At the same time as the grid electrification[2] progressed, solar home systems (SHSs) were disseminated to rural households furthest from the grid, although the dissemination of SHSs was not as programmatic or systematic as the national grid strategy. It was only in the late 1990s that SHSs (mainly solar PVs) and other renewable energy technologies received policy priority, and the Department of Minerals and Energy is now formulating the white paper on renewable energy policy. Although difficult to quantify, it is assumed that some rural communities have access to solar systems in their households, clinics, schools and telecommunications.

Notwithstanding the impressive number of households who now have access to grid or non-grid services[3], severe energy deprivation persists in many rural areas of South Africa, particularly in the Eastern Cape, where this study was undertaken. Also, there is to date little evidence that electrification leads to the creation of SMMEs which would improve the chances of income generation. Yet in the long run, it is indisputable that grid or non-grid electricity could improve the livelihoods of rural households as they provide high quality, cleaner and more efficient energy services that are essential for the welfare of households and communities.

1.2 An overview of rural development issues

In terms of per capita income, Eastern Cape (once the home of Transkei and Ciskei homelands)[4] is one of the poorest provinces in South Africa. While the homeland governance was abolished in 1994, the situation in this province has had little changes. These former homelands are marked by abject poverty and underdevelopment.

Most rural households in the Eastern Cape still suffer from energy poverty. Energy poverty is defined as:

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2 Provision of electricity through the national grid transmission lines.

3 Grid services refer to the provision of electricity by the service provider, in this case Eskom, to the households. Non-grid services in this context refer to the provision of electricity to the households through the use of stand-alone solar home systems.

4 The homelands did not have an economic function, other than as reserves for labour, and the dumping grounds for people perceived as surplus requirements in white South Africa during the apartheid era.

a) limited access to basic energy services,

b) relatively high energy expenditure vis-à-vis household income,

c) lack of income-generating activities derived from energy

On the other hand, energy poverty is aggravated by increased energy burden on women, lack of access to information and education about energy, inadequate household and community welfare, and lack of basic infrastructural development in many rural areas.

Lack of basic energy services

Basic energy needs refer to the energy that are needed by people to carry out their core daily activities. Many rural households struggle to cook decent meals, provide good lighting in the dwellings, space heating in a convenient, safe and efficient manner, etc. Most households still rely on fuelwood, paraffin, coal and candles to meet most of their basic energy needs. The use of such fuels has negative impacts on the users' health and safety as well as the environment in which they live.

High cost of energy for households

Expenditure on energy constitutes a major share of rural households' incomes -- more than for their urban counterparts. Generally, rural households are poor and their negligible incomes are seriously stretched. A significant proportion of household income is spent on paraffin, candles and even fuelwood. Some of these households further spend additional money in order to buy electricity (Eberhard & van Horen 1995: 59). Using candles, coal, paraffin and fuelwood is less cost-effective in the long term and exposes these households to other costs as well. These costs may be in the form of medical attention needed due to the use of fuels such as paraffin and wood because of the emissions, and respiratory diseases from coal use, paraffin poisoning amongst children, and residential fires (Mehlwana 1999a: 19-28).

Lack of income-generating activities

Lack of genuine income-generating activities in the rural areas is the foremost cause of unemployment, poverty and deprivation. Provision of electricity could be a vehicle for development and income-generating activities. The lack of income-generating activities has resulted in a large number of households depending on government grants and irregular remittances from urban areas. Subsistence farming is no longer a feasible alternative in many rural areas in South Africa: where overgrazing and over-cultivation have contributed to poor soil fertility, which exacerbates energy poverty since the nearby lands no longer support the growth of fuelwood crops.[5]

Increased energy burden on women

Women living in the rural areas have the responsibility of managing households just like those living in urban areas, but theirs may be more complicated because of the conditions they live in and their exposure to 'energy poverty'. Energy poverty in this case means that they do not have sufficient fuels, such as paraffin, gas and even electricity to fulfil their basic energy needs. Harvesting wood remains a 'women's occupation' in rural areas, and women spend long hours collecting fuelwood. They also make fires for cooking or heating, which further exposes them to harmful particulates. It is assumed that access to electricity could ease women's work burden and contribute to cleaner and healthier living conditions for rural households, yet this has not happened in a large scale.

Lack of access to information and education

Access to useful information and education is a problem in rural areas. Although a number of people have radios and televisions, there may be problems in accessing energy services to power these appliances. The high cost of batteries militates against rural people getting crucial information. Students in rural areas do not have access to modern educational technologies, such as computers, projectors and video machines, which facilitate access to information. Were schools to be equipped with such materials, they would still require the necessary energy services to operate them. Lighting is also essential to meeting basic energy needs of households, but quality lighting is lacking in many rural areas. Good lighting contributes to better education, as children can study and do homework at night.

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5 Mearns & Leach (1991), O'Keefe & Munslow (1989), Eberhard & Van Horen (1995), among many, argue that the so-called 'fuelwood crisis' is not an energy problem. This is because fuelwood is only a by-product of land clearance for agriculture and settlements, etc. In many instances, clearing wood is important for development purposes. Moreover, causes of deforestation are complex and cannot be simply attributed to wood collection or agriculture. Despite this view, indiscriminate harvesting of fuelwood does contribute to poor soil fertility (see also Hurst & Barnett 1990).

Inadequate community welfare and security

Energy needs are not only linked to the household welfare, but also to the community's welfare. The provision of adequate street lighting (and outside people's dwellings) eases security concerns of rural communities, as quality lighting could deter crime and violence. Community security is also linked to exposure to residential fires and paraffin ingestion. Entertainment is good for a community's social life. There is little entertainment in the afternoons and late evenings in rural areas because most households do not have access to electricity or entertainment appliances. Lack of all these services hampers the quality of life of rural dwellers.

General lack of infrastructural development in rural areas

There is lack of access to other basic needs such as road infrastructure, communication, transportation, health facilities, community halls and clean water in the rural areas. Lack of basic infrastructure means that it is difficult for people to move around and it hinders opportunities to have easy access to the outside world that can provide employment opportunities. This limitation in communication and transportation could greatly affect the extent to which energy services could be provided.

1.3 Hypotheses and Key Research Questions

The aim of this thesis is to explore the complexities and dynamics of energy use in low-income rural households in the Eastern Cape. It proposes that an end-use analysis (one looking at what people are using energy for) and an assessment of household energy needs is a more efficient policy tool to understand these complexities and make energy planning more effective. It can be argued that electricity provision is an important, albeit insufficient strategy of intervention. The following interlinked hypothesis are explored in subsequent chapters:

- Strategies to address household energy use should respond to households' needs and should be 'situational' that is vary according to specific contexts that determine fuel use. While the costs and efficacy of certain fuels are probably the most important determinants, the context within which one particular energy is used is very important. Socio-economic (as well as socio-cultural) issues determine how and what fuels households use at any given time.

- Energy needs are not the same as energy demand. While every household need energy for survival, it does not necessarily mean that they can afford or use such energy. There are many reasons that prevent households from using energy such as electricity. A 'supply-driven approach' to household energy use is not equipped to identify underlying reasons for non-utilisation of energy sources. An end-use or demand-side approach can reveal complex fuel-use patterns. The rural energy situation is not simply about the supply meeting the demand, but about analysing the broader picture and understanding the reasons behind peoples' use of energy.

- Simply transferring technology to an area that suffers from energy poverty or development deficiencies may not work. The comparative analysis between electricity delivery modes (grid and non-grid electricity supply options) brings this point home. There is a primary need to analyse the needs of households before any equipment (such as Solar Home Systems) can be imposed as a solution. It follows that households should at least be given a choice as to the best strategy which fits their situation or needs. This is empowering and goes a long way to achieving sustainable development.

Though this thesis will discuss these issues, the primary purpose of this thesis is not to explore the theory of sustainable energy or integrated energy planning. Such analysis is adequately addressed elsewhere (e.g. Eberhard & van Horen 1995; Barnett et al 1982; Goldenburg et al 1987; Loon 1996; Elliot 1994; El Mahgary & Biswas 1995). This study explores the impact of non-grid and grid electricity on the needs of rural households in selected communities of the surveyed areas.

The questions explored in this thesis include:

- To what extent does a household's location influence its use of energy?

- Does poverty contribute to lack of appropriate energy use, or does the lack of such energy services exacerbate poverty?

- Why is it that households find it difficult to switch completely to 'modern' energy sources for thermal applications for example, yet find it easier to do so for media appliances?

- How can we turn the energy needs of households into effective energy demand?

- More specifically, how should policy makers approach energy poverty in rural areas?
- What must be done or avoided in the implementation of sustainable energy options?

1.4 The supply-driven approach to household energy planning

Historically, most household energy strategies have been about increasing the level of energy supply to meet the increasing demand for energy services, not about increasing energy demand through the selection of the best supply option available. The difference between these two approaches is critical in terms of understanding household energy needs and responding to them. The supply-driven approach to household energy entails looking at energy sub-sectors according to individual energy sources, such as electricity, paraffin, gas, wood, etc. The policies emanating from such an analysis are much more supply-oriented because they focus almost exclusively at the generation, transmission and distribution of energy services, with not so much emphasis on the factors that affect the demand of energy.

The results of this approach would be a bias in favour of big energy consumers, such as industries and wealthy households, at the expense of poor households in rural areas. It is obvious that most of the income that energy producers gain is from the big industries and, naturally, they are given priority over consumers that use the least electricity. This approach fails to recognise that, in reality, this is not *effective* demand. Poor rural households need improved energy services, but cannot utilise them when provided, for different reasons.

The supply-driven approach is informed by and derived from a transitional model, which argues along lines similar to the neo-classical modernisation theory (Rostow 1960). The transitional model sees household energy consumption in terms of the 'energy ladder' (for example, Viljoen 1990), and assumes that households' energy consumption begins with traditional fuels (biomass fuels) culminating in the use of modern fuels (electricity). In between these are various stages of 'transition'. Multiple fuel-use (the use of more than one fuel for one end-use) is therefore seen as a temporary phase towards full modernisation.

While this full modernisation theory is useful in understanding the global energy shifts, it has been viewed as irrelevant and static in explaining the micro energy complexities.

Firstly, the model cannot adequately explain intra-household issues such as gender, decision-making issues, etc and how these affect energy use. Secondly, the model is strongly associated with the a-historical modernisation theory. Thirdly, and more importantly for this thesis, this model is weak in explaining the prevalence of multiple fuel-use and cannot explain fuel back switching.[6]

1.5 Structure of thesis

In presenting research findings, this thesis is organised into six chapters:

Chapter 2 discusses the methodology used to collect and analyse the data, as well as data limitations of the study.

Chapter 3 analyses the socio-economic profiles of the households sampled and the extent to which these are linked to household energy use. This analysis shows the relationship between factors such as household membership and gender, educational levels, income levels and sources, and the use of energy in the home.

Chapter 4 compares the patterns of energy end-use among grid-electrified, non-grid-electrified and non-electrified households. It looks particularly at the main energy end-uses, the combinations of fuel-appliances and costs of various electricity supply options. It emphasises the importance the analysis of end-use in unravelling the complexities of household energy use. Furthermore, it argues that multiple fuel-use is a permanent phenomenon.

Chapter 5 explores whether electrification (grid and non-grid) could address energy poverty or sustainable energy development in rural areas. This chapter, following from the previous chapter, is the analysis of households' perceptions on different electricity delivery modes. The 'modes' under discussion here are perceptions about grid and non-grid electricity (concentrating on solar home systems).

The final chapter provides the conclusion and recommendations.

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[6] See Eberhard and van Horen (1995: 66-70) and Ross (1993) for detailed discussion on the limitations of the transitional model.)

CHAPTER 2: Research Methodology

2.1 Introduction

This work is based on the analysis of household survey data from selected rural communities in the Eastern Cape Province where Eskom-Shell Joint Venture (JV) has been undertaking its non-grid solar electrification since 1999. The Province is considered one of the most impoverished in South Africa (Statistics South Africa 2001). The sample was made up of three clusters of households, namely: those with grid electricity, those with non-grid electricity, as well as those that do not have any electricity at all. This permitted the comparison of how households use energy and the impacts of providing solar electricity to these households. Grid electricity is the electricity supplied by Eskom through its national grid. Non-grid electricity here refers to the SHSs that have been installed through the governments' non-grid concessions programme. Households that were provided with solar PV electricity by the Eskom-Shell JV make up the majority of the sample since the focus of the study was on non-grid electrification. A small number of grid-electrified and non-electrified households were included in the survey for comparative purposes. The reason for interviewing such a small number of households in these two categories was that the study formed a small part of a project designed mainly to monitor the impacts of non-grid electrification through SHSs in the Eastern Cape.

It is often argued that the method of generating and organising information/data is as important as the research itself. Section 2.2 below provides information on the samples and sub-samples and size, and provides a critique of the research methods used.

2.2 The study area

The focus of the research project was on households supplied with non-grid electricity in areas where Eskom-Shell JV had piloted their non-grid electricity with SHSs since 1999. However, to understand the impact of solar electrification on these non-grid users, comparisons with small samples of households using conventional grid electricity, and households without access to any type of electricity serve as control groups. The samples were selected from six rural areas, namely Mt. Fletcher, Matatiele, Mt. Ayliff, Flagstaff, Tabankulu and Bizana (shown in Figure 2-1) in the North-Eastern region of the Eastern Cape (former Transkei). The figure shows the areas and their proximity to Port Shepstone, which is the headquarters of Eskom-Shell JV. It also shows their proximity to the nearest city, Durban and the important commercial town, Umtata. Although, there were seven areas where Eskom-Shell JV had installed SHSs, Mt Frere was not included in the research due to the fact that it is difficult to reach and so far had very few SHSs installed.

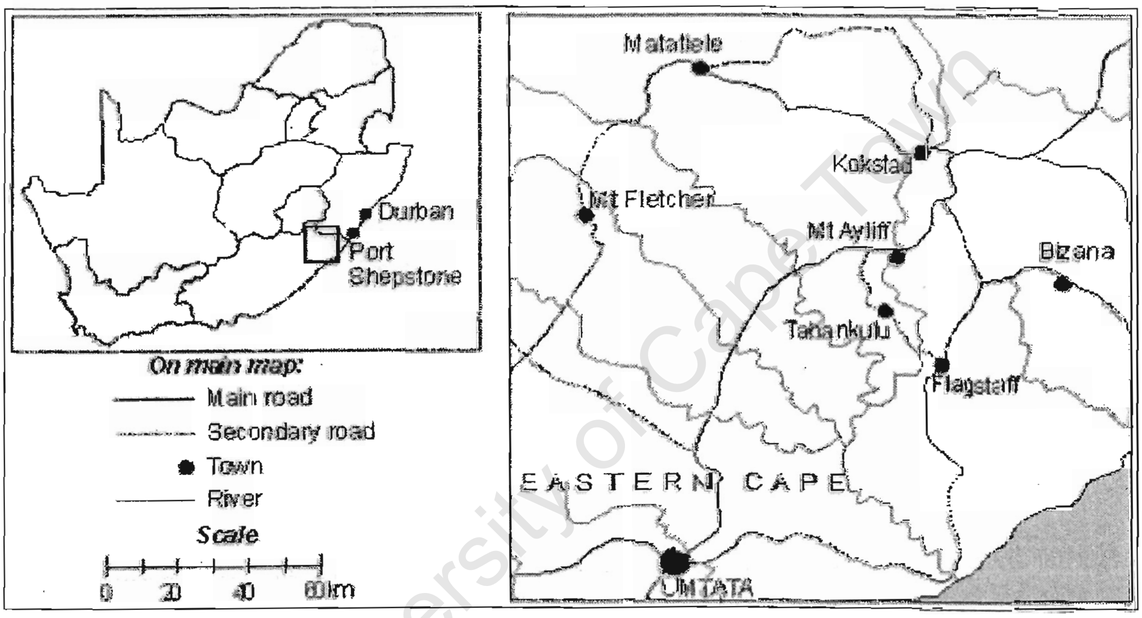

Figure 2-1: Map of the study areas in the Eastern Cape

During the period of research Eskom-Shell JV had installed 6000 SHSs in all their concession area which included the Eastern Cape and KwaZulu-Natal Provinces.

2.3 Sample selection

The numbers of SHSs installed varied from area to area. As mentioned above, each of the six areas that had SHSs installed by Eskom-Shell JV had a number of villages within them. The households were selected in proportion to the number of SHSs installed in that area. Some villages had more SHSs than others depending on the number of households in a particular village that had applied for the SHSs to be installed in their homes. Eskom-Shell accepts applications from households which have regular incomes, this may have limited the number of installations in certain areas. To illustrate this point Table 2-1 below shows the distribution of sampled households amongst the areas selected for the study. At the time of fieldwork, the service providers (Eskom-Shell JV) did not have the exact numbers of SHSs installed in these villages, as some of the information had not been updated on their database[7]. The sample was as representative as possible of the households in selected villages. For instance, out of the 72 households with SHSs in the seven Bizana villages, 51 (70%) were selected and out of the 74 households with SHSs in the six Tabankulu villages, 23 (31%) were selected (Table 2.1). This form of sampling was also adopted to ensure that the impacts of SHSs are captured in these villages as they had more SHSs installed than in other areas. It would have been difficult to assess the impact in villages with only a few SHSs installed, as it would not have been an overall reflection of the service provided to these villages. It was easier for service providers to install in bulk where households are dense but here there is always a danger that negative impressions by users pass rapidly from neighbour to neighbour. This would not be the case where households live far apart. The higher the number of SHSs installed in the area, the more diverse the issues that have to be addressed by the service providers and the households.

Area	*No. of villages selected*	*No. of SHSs installed in villages selected*	*Non-grid households samples*	*Grid-electrified households selected*	*Non-electrified households selected*	*Total*
Mt. Fletcher	3	73	32 (44%)			32
Bizana	7	72	51 (71%)		50	101
Mt. Ayliff	5	105	45 (43%)		15	60
Flagstaff	8	123	50 (41%)	25		75
Tabankulu	6	74	23 (31%)	26		49
Matatiele	2	90	31 (34%)			31
Total	31	537	232 (43%)	51	65	348

Table 2-1: Sample distribution and number of households per surveyed area

[7] At the time of research (June 2001), Eskom-Shell JV had a list of areas that were provided with SHSs which was further broken down into different communities per area. This list also had the numbers of SHSs in each community. However, due to the intensity of the installation process, this list was not updated and thus not all the SHSs installed were recorded.

Area	*Total number of villages with SHSs installed*	*No. of villages with SHSs selected*	*Percentage of villages with SHSs selected*	*Total number of systems installed in each area*	*Percentage of sampled households with SHSs in the area*
Mt. Fletcher	78	3	4%	1147	3%
Bizana	50	7	14%	868	6%
Mt. Ayliff	41	5	12%	600	8%
Flagstaff	61	8	13%	1053	5%
Tabankulu	54	6	11%	703	3%
Matatiele	48	2	4%	548	6%
Total	332	31	9%	4919	5%

Table 2-2: Number of SHSs installed in each area

A number of reasons affect the sample selection. These are the number of households that could be interviewed in an area, the time that could be spent in a particular area and the distances between the researched areas as will be discussed below in the section dealing with the limitations of research methodology. The sample size of non-grid electrified households (232) was considered to be as *representative* as possible of the 6000 households in which Eskom-Shell JV had installed solar systems. The sample of grid and non-electrified households were selected randomly in the vicinity of the villages that were provided with solar systems. An important reason for interviewing non-electrified households was to assess how people without any form of electricity felt about both electricity supply options (non-grid and grid electricity) in their areas and to compare the livelihoods of these households with the electrified households.

Communities	**SHSs installed**[8]	***No. of households interviewed***
Caba	30	14 (46%)
Chibini	60	17 (28.3%)
Total	90	31 (34.4%)

Table 2-3: Surveyed communities in Matatiele and the number of SHSs installed through the Eskom-Shell JV project.

In order to illustrate the sample selection procedure, Table 2-3 shows the number of households with SHSs that were interviewed in the Matatiele area compared to the total number of households that had SHSs installed. This procedure was applied in all the

[8] Figures of solar systems installed in these areas in 2001 are taken from the Eskom-Shell JV customer database.

areas surveyed as they were all divided into communities, each with a number of SHSs installed. The aim of this procedure was to ensure that the numbers of households selected were at least representative of the households with SHSs in these communities. Out of all the households with SHSs in Mt. Ayliff, 44% was interviewed, In Bizana 68% was interviewed, In Tabankulu 31% was interviewed, in Flagstaff 44% was interviewed and in Mt. Fletcher over 50% with SHSs were interviewed.

Table 2-4 shows some of the demographic data of the areas where the study was undertaken. Although this data dates back to 1998, it was the most recent data that could be found that shows the demographics for these areas in particular. The areas fall under three different local municipalities in the Eastern Cape.

Municipalities	**Areas in Eastern Cape Municipalities**	***Total households***	***Grid electrified households***	***Non-grid electrified through Eskom-Shell JV***	***Non-electrified households***
Umzimvubu	Mt Ayliff, Mt Frere, Matatiele & Mt Fletcher	81449	4445 (5.4%)	2398 (3%)	74606 (91%)
Bizana	Bizana	41838	2817 (6.8%)	868 (2.0%)	38153 (91%)
Tabankulu	Tabankulu	23303	658 (2.9%)	703 (3.0%)	21942 (94%)

Table 2-4: Demographic information of researched areas
Source: Municipal Demarcation Board: South Africa (2002)

It is important to note that there was no specific information available on each of the other areas researched. Mt Ayliff, Mt Frere, Matatiele and Mt Fletcher areas are under the Umzimvubu municipality. The information in Table 2-3 is not only that of the research communities but all of the surrounding villages and towns as well. The table shows the number of households under each municipality, the numbers and percentages of households with grid and non-grid electricity and the number of households with no electricity. From this table it can be seen that there is still a high backlog of non-electrified households. According to the Minister of Minerals and Energy, the backlog in the Eastern Cape province, as at December 2001 was 610 623 households (Mlambo-Ngcuka 2002).

2.4 Research techniques

Structured questionnaires were used in this work for the quantitative research. The questionnaire for solar home systems users was adapted to suit grid and non-electrified households (See Appendix 1 for the complete set of survey questions for solar electrified households). There were also many informal interviews with households that were provided with SHSs. Questions covering various issues regarding the households were piloted so as to gather information on these households. The issues included in the questionnaire covered demographic information of the different households, the application process for non-grid and grid electricity and to determine why some households had not applied for electricity at all. Households were also asked about the use of electricity and other energy sources and the impact these had on their livelihoods. There were also questions on income of households to determine their economic backgrounds.

2.5 Limitations of the research methodology

There are some limitations that may impinge on the interpretation of the research findings. Below is a brief list of the shortcomings of the research process and methodology.

Since the households were selected from lists provided by Eskom-Shell JV, there could be several sources of error attributable to the way their lists were drawn up. The households that were serviced by Eskom-Shell JV fall into a certain income brackets. It was a set policy by the company to provide SHSs only to households that could afford them. Obviously these households had to have a regular monthly income derived from formal or reliable informal sources or pensions and other state grants. This 'selection' does not apply for the grid-electrified households. For grid and non electrified households income status and income sources were not known prior to the time of the interviews. Other sources of error come from the concepts used in this study and many similar studies and are defined as follows:

Definition of 'household'– for the purpose of this study, the household is defined as a unit whereby family members (including extended family) are contributing monetarily or otherwise to the upkeep of the home. In the rural areas as many as ten people or more can belong to a household and some members may not be present at all times due to the fact that they live in big towns or cities where they may have some form of employment or are living with other relatives but still are contributing to their rural home.

Identification of household head– For the purposes of this study, the head of the household is identified as the main person (regardless of gender or age) contributing to the household (unless otherwise stated by the household) with money, food, clothing, school fees and provision of shelter for the household members. The household head is also the main person that makes final decisions affecting the way that particular household is maintained and fulfilling its day-to-day basic and other requirements.

Estimation of income– As mentioned above, households selected for this study, especially those with SHSs were concentrated in certain income brackets since Eskom-Shell JV used a regular income or pension as a prerequisite for obtaining a SHS. Households that did not meet such requirements did not qualify to have a SHS installed. They were thus left out from the study. Households with grid electricity and those not electrified were not selected according to the amount of money they earned but the selection was based on their geographical location since they had to be at least in close proximity to non-grid electrified households.

Reliability of data, misinformation by respondents and errors introduced by interviewers – Not all the information provided by respondents is without error. Some respondents did not have all the correct information needed regarding the household they lived in such as the age of household members, education levels of members, type of work done, prices of different sources of fuel, household income and expenditure on fuels. A lengthy questionnaire (administered by interviewers in face-to-face meetings) was used to record information. It is never possible to eliminate "don't knows" from respondents, as they may not have all the information asked for in the questionnaire. It is also impossible to avoid entirely errors made by the interviewers no matter how much training they have received from the research team.

Difficult terrains and inaccessibility of some homesteads – The Eastern Cape is situated in mountainous terrains, which are often hard to reach. Although an effort was made to reach most households in these areas, it was unfortunate that others could not be reached because they are situated in locations that were too difficult to access. At the time of research, Eskom-Shell JV had installed 6000 SHSs in the Eastern Cape. A major difficulty in carrying out the interviews in all the six areas was that the homesteads were situated far apart from each other and frequently far from the main roads. The results reported here may be biased towards households in areas that are easy to access. It may also be true that installers delivered systems first to the more accessible homes. The sample had to be built on door-to-door interviews and depended on the availability of household members willing to be interviewed.

Representative sample of non-grid electrified households in the broader context – In comparison to the Eskom-Shell JV pilot programme universe; households selected for the study were representative of the non-grid electrified households in the selected areas. The challenge during the time of research in this Province was that although there were 6000 SHSs already installed in the researched areas, they were scattered all over these areas. Some areas had more systems than others, whilst other areas may have been accessible but had a few systems installed which would have made the monitoring process difficult.

Time constraints – At least a full day had to be allocated for training of the interviewers who were selected from local people that had at least matric or grade 12 qualifications. These people had to be trained on how to conduct interviews. Due to time constraints, it was difficult to offer adequate training to all the interviewers and some issues were only addressed during the course of the fieldwork.

Reliability of 'two way' translations – A major problem was that the questionnaires were in the English language and during the training sessions these had to be translated to the local languages. The language barrier also posed a problem during the interviews. Interviewers had to translate each question asked of the respondent into the local language and translate the responses back into English. Each questionnaire had to be checked with the enumerator to ensure that the information given was correct to the best of their knowledge. Other constraints were caused by the fact that some households were situated so far away from main roads that it took more time to reach them than to interview them.

Unequal sampling – It must be noted that because the numbers of households (non-grid, grid and non-electrified) interviewed were not the same, results may be skewed. For instance, the non-grid electrified households' data may generate more representative statistics than the rest of the households in the sample. The reason for this is that the survey was initially designed as a 'before and after' study. Households were to be selected from those who had applied for but not yet received their solar systems. These households were to be baseline from which the effects of SHSs could be measured is a second series of interviews a year or two later. Eskom-Shell JV went ahead with 6000 installations before the research team had the final agreement to undertake the study. Households with grid electricity and non-electrified households were surveyed as a proxy for a baseline and only a limited number of such households could be found adjacent to the villages in the researched areas. In the six areas there were only two areas that were households with grid electricity and two with households who had no electricity at all.

Such limitations inevitably have a bearing on the kind of the analysis presented in this thesis. However, the findings here concentrate on households' energy use patterns and responses to one particular electrification option, that of SHSs. Multiple-fuel use figures large and confirms earlier research conducted in rural areas and low-income areas of South Africa.

CHAPTER 3:
Linkages between households' socio-economic profile and access to electrification

> Technical changes, which are not associated with changes in the related social structures, are unlikely to lead to widespread and long-term increases in welfare, that is, the supply of new forms of (energy) hardware is not a sufficient condition for reduction of poverty (Barnett et al 1982: 4).

3.1 Introduction

Energy use, particularly in an under developed context, cannot be understood in isolation from inter- and intra-households issues which shape them. A range of fuel options may be 'accessible', and yet individual households may find it difficult to use these. One of the most important reasons that militate against the use of appropriate energy is the household's socio-economic status. This chapter explores the baseline with which energy use patterns can be measured. It presents the socio-economic profiles of the sampled households and their effects on energy use. The purpose of this analysis is to demonstrate an interface and symbiosis between gender, educational status and income.

i. There is consensus in energy discourse that the determinants of household energy use are qualitative and quantitative. The gender of the household head (Annecke 1993), intra-household power dynamics (James 1997), enculturation (Ross 1993; Bank 1996; Mehlwana & Qase 1998) or socialisation (Jones & Aitken 1996; White et al 1998) are cited as essential ingredients shaping the use of energy in households. This chapter argues that fuel use patterns amongst low-income households are determined by the interplay of socio-cultural and socio-economic aspects, such as income, education, etc. To understand energy poverty, it is imperative that these factors are unravelled.

ii. The economic notions of cost, affordability or accessibility are still applicable, but it would be an oversimplification of a complex situation to consider these alone as the basis for household energy use. An analysis should at first attempt to unpack wider households issues that affect the costs, affordability and accessibility of fuels. Rather than attempting to understand whether energy is available or affordable, the barriers that militate against the use of household fuels need to be understood first. Such analysis would reveal key socio-economic variables and their contribution to energy poverty.

iii. Implicitly, this chapter touches on the following assumptions that influence household energy debates:

- The different categories of households (i.e. non-grid electrified, grid-electrified and non-electrified) have different gender profiles, which invariably affect their energy use.

- The level of education of household members, particularly the head of the households, as well as income levels determine households' access to energy resources such as grid or non-grid electricity and this can have a direct bearing on the type of energy used.

- Women-led households in rural areas are more susceptible to being impoverished than men-led households. This is because women are more likely to be outside the formal economy than their men counterparts. This is a historical reality, which has put women, particularly in the rural areas at the bottom of the income ladder (Annecke 1998: 12).

There were distinctive socio-economic differences between the grid and non-grid electrified and non-electrified households, particularly gender and income flows. These differences influenced the access and use of fuels in these households. To a certain extent, educational levels of the household heads appeared to have a bearing on determining household life chances, as Table 3-1 below shows.

Elec. status	*None*	*Primary*	*Secondary*	*Matric*	*Post-Matric*
Non grid	24%	14%	26%	13%	24%
Grid	12%	20%	22%	39%	8%
Non electrified	37%	33%	22%	5%	3%
All	24%	19%	24%	15%	17%

Table 3-1: Percentage of household heads with highest education levels

Perhaps, it should be expected that most households possessed little higher education. This means that, overall; these household members stood little chance of landing well-paying jobs in the competitive formal sector. It is also noticeable in Table 3-1 above that household heads in non-electrified households fared the worst in terms of education. Most household heads in non-electrified areas surveyed had either little or no formal education. Not surprisingly, most of these households fall into the lowest income. They lack job skills and adequate access to energy services as shown in Figure 3.5 that majority of households in these groups earn less than electrified households.

3.2 The engendered nature of poverty

Figure 3-1 below shows the different electrification statuses and the percentages of each gender of households' heads in each group. The non-grid electrified households have more male-headed households than female-headed households in almost all the villages surveyed. The argument in this case is that male-headed households have better chances of having the SHSs installed than the female-headed households. Households that had SHSs had to meet income requirements set by Eskom-Shell JV.

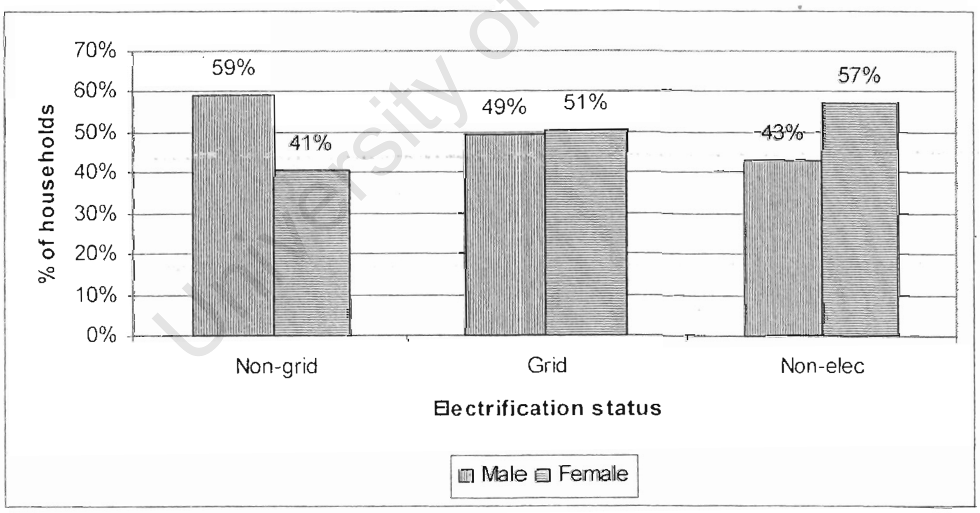

Figure 3-1: Gender of the household head in all surveyed households

The households that could afford the solar systems had to have adequate income and Figure 3-1 above shows that these households are mostly male-headed. They could afford the payment of R52 monthly service fee for the solar home systems on the basis that males were more likely to be employed than women and would be able to support their families financially. Traditionally men are mostly engaged in the formal / wage work and earn more than women do and if a family has both male and female, chances work and earn more than women do and if a family has both male and female, chances are that there is some form of income coming into the household. Although the numbers of male-headed households are higher in the non-grid electrified areas, women in Matatiele also had means of supplementing income derived from the formal economy by informal incomes such hawking in the streets, selling fruit, vegetables and other merchandise at taxi ranks for passengers embarking on journeys to a major town nearby, Kokstad – a distance of about 74 km.

Figure 3-1 also shows the percentages of households led by males and females in the grid-electrified category of households. The grid-electrified households sample was selected in Flagstaff and Tabankulu where there are also households that have solar PVs installed by the Eskom-Shell Joint Venture. There is little difference in terms of percentages of the male and female-headed households and this may be explained by the fact that the grid electrified areas surveyed do not offer much in terms of employment opportunities, as they are situated deep in arguably the most unproductive area in the Eastern Cape. In such cases, men often migrate to look for jobs in the cities leaving women to manage the households.

It was observed that more women in the grid-electrified sampled areas were either involved in formal employment or earned state grants, as they were able to pay for their electricity supply. The incomes received by these households ensured that people 'purchased' electricity whenever they could, even more so when they had pre-payment meters.[9]

The number of female-headed households was much higher in the non-electrified households' sample particularly in Bizana. The non-electrified households did not have as high incomes compared to the grid and non-grid electrified households (Figures 3-5 & 3-6) which emphasises that the female-headed households are often more subjected to poverty and in this case they also have to live without electricity whether grid or non-grid. Nevertheless, in instances where males were heads of households, it did not necessarily mean that these households were well off as employment opportunities could not be guaranteed.

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9 These households were only required to pay a once-off installation fee for grid electricity supply, which ranged from R60 to R150 in the past five years.

3.3 Income in the sampled households

In the past, rural studies estimated that unemployment among the rural population is over 50% (see May et al 1998) and the majority of rural households depended on informal sector and government grants. The present study included households engaged in informal and formal employment sectors allowing analysis to be made of the different amounts earned.

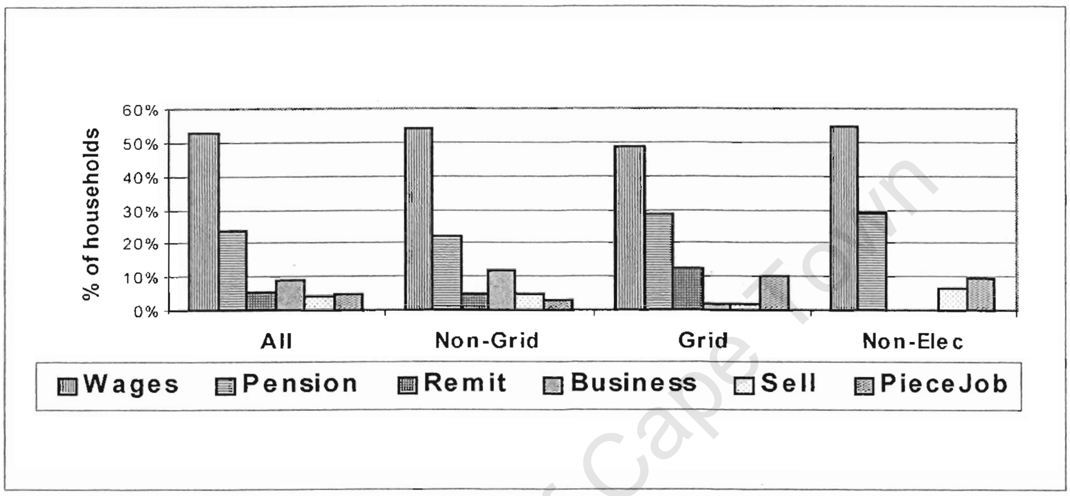

Figure 3-2: Main income source of the sampled households

In looking at the three household categories analysed in this thesis, there was an obvious difference between the electrified and non-electrified households in terms of income. Majority of solar electrified households had regular and higher incomes when compared to grid-electrified and non-electrified households. Compared to grid electrified and non-electrified households, more than 45% of the sampled non-grid electrified households had an income of more than R1800 per month (see Figure 3.6). Having a regular and relatively high income puts these households at an advantage of having non-grid electricity services delivered to them, as it was an important criterion to have a steady income if households wanted solar PVs. This sort of requirement puts households with low incomes at a further disadvantage, as it also meant a lack of access to alternative energy services. The lack of access to alternative energy services has health implications as well, such as respiratory diseases from biomass and paraffin combustion which households without appropriate energy sources are exposed to.

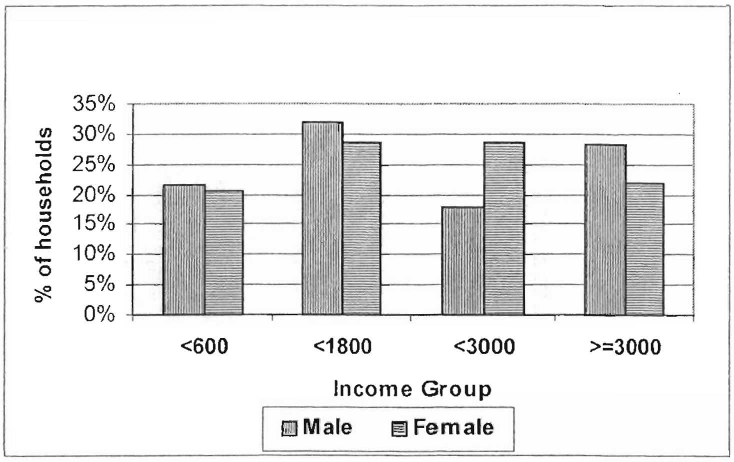

Figure 3-3: Income of the household head in non-grid households

Figure 3-3 shows the differences between incomes earned by male-headed and female-headed households in non-grid electrified households. Although the differences are little between households earning less than R1800, the graph shows that female-headed households are greater in the R1800 – R3000 income groups. Not only could non-grid electrified households afford to pay for their non-grid electricity services; they also had access to cleaner and more reliable energy sources for lighting and media applications. They could purchase liquefied petroleum gas (LPG) instead of collecting wood and buy larger (and therefore cheaper) quantities of paraffin because of their high incomes.

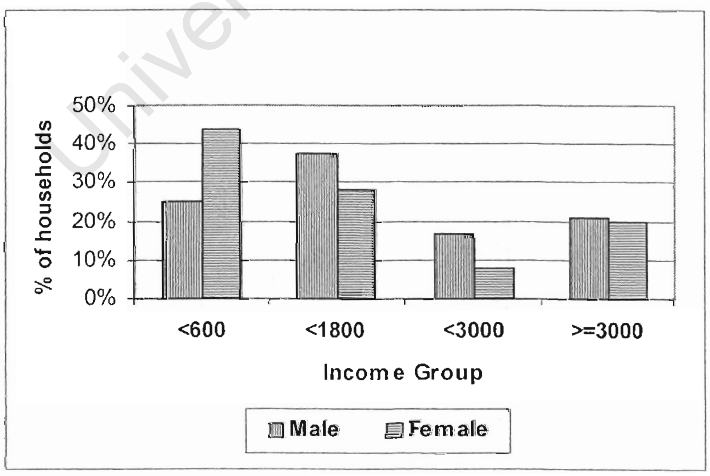

Figure 3-4: Income of the household head in grid electrified households

There was a difference between income distribution amongst male-headed and female-headed households of grid- and non-grid-electrified households. Households in non-grid electrified households had incomes of above R600 – R3000 per month and there was an almost equal distribution of this amongst male and female-headed households (Figure 3-3). Regarding female-headed households earning R600 and less, figures 3-3 & 3-4 show that 22% of non-grid electrified households were headed by women and 44% of grid electrified households in this income group were also headed by women.

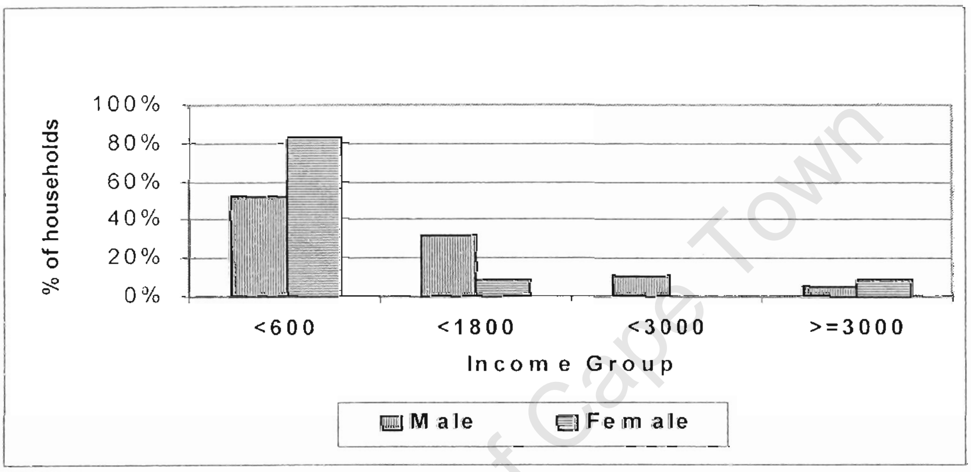

Figure 3-5: Income of the household head in non-electrified households

Majority of non-electrified households earn less income than the electrified households (see Figure 3.6). Since women led most of the non-electrified households (Figure 3-1) meant that these impoverished women were burdened with finding the necessary energy sources to prepare food for their families, or manage their households. Noticeable in this study (see Figures 3-1 & 3-5) was that women-headed households in the non-electrified areas had the lowest incomes, in fact 83% of the female-headed households in the non-electrified areas earned R600 or less. This to a certain degree confirms the often-mentioned observation in energy and gender studies that female-headed households are more susceptible to poverty than male-headed households (Annecke 1993; May et al 1998).

Figure 3-6 shows that 65% of the income earners in the non-electrified households earned R600 or less per month compared to the 21% and 35% of the non-grid electrified and grid-electrified households respectively. There were also low numbers of the non-electrified households earning R1800 or more, which emphasises that these households are impoverished. Low incomes made it difficult for the non-electrified households to plan their purchases of, or payments towards, energy services. Obviously, with this variation in income flows, these households could not afford the monthly payments of non-grid services. Having a grid electricity supply could be an option for these impoverished households. However, they would still have to consider the installation fee, and purchases of electricity. The fact that majority of poor households are situated in deep rural areas is a further disadvantage, as it is expensive to extend electricity to these areas. These would, in the ultimate analysis, end up being provided with non-grid electricity.

Partly because of their impoverished nature and the limited choice of fuels, the non-electrified households depend on fuelwood, paraffin and candles to meet their daily energy needs as it will be discussed in Chapter 4 where energy use in the surveyed areas will be analysed. The use of these fuels puts people at health and safety risk (cf. Eberhard & Van Horen 1995: 73; Aitken & Jones 1996: 125).

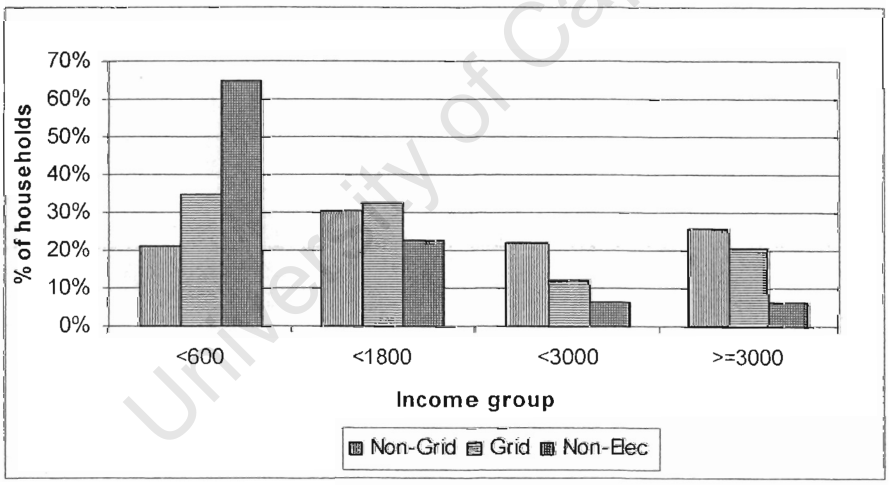

Figure 3-6: Income vs. electrification status of surveyed households

Households in grid- and non-grid-electrified categories had significantly higher incomes compared with non-electrified households (Figure 3-6), making them better candidates for solar home systems or grid electricity. For instance, the Eskom-Shell JV's main criterion when selecting households for the solar systems was their income status.

3.4 Conclusion

Collectively, rural households face immense pressures in the face of poverty. However, it would be reckless to lump all rural households in the same category or level of impoverishment. There are subtle differences within rural areas, which shape their life chances. This chapter has tried to elucidate these socio-economic differences. Such information is crucial in that it puts their energy use patterns (see Chapter 4) into context. Another important aspect of this chapter is the interface between income and gender, and the way this interface is integral in household energy use as income and gender determine the types of energy sources used by households.

Sustainability means that the users should be able to use energy resources or services in a way that does not compromise their livelihoods. This means that users should be able to afford energy services being provided. This chapter has brought to the fore the plight of rural households who are invisible to policy.

CHAPTER 4:
Fuel-use patterns of the sampled rural households

Households suffering from unemployment and poverty rely on less convenient and often unhealthy fuels. Grid electricity may not satisfy all the energy needs of low-income households (DME 1998: 13).

4.1 Introduction

The sampled households' energy end-use patterns are indicative of poor rural areas in South Africa and, indeed, in the developing world. They are characterised by a high dependence on biomass fuels, particularly fuelwood and the corresponding low use of commercial fuels. The World Energy Council (WEC) (1999: 35) stated that most poor rural households use biomass for cooking and candles and paraffin lamps for lighting. In South Africa's rural areas, there is a very high use of paraffin for thermal applications partly because it is 'affordable' and accessible, and partly because of the emerging fuelwood scarcities.

Many electrified rural households do not use electricity to the optimum. Of the sampled grid-electrified households in Tabankulu and Flagstaff in this study, a significant number of the households used paraffin for cooking and space heating (as well as wood) as shown in Figures 4-3 and 4.7. This was mainly because of higher operational costs and expensive electrical appliances. Nevertheless, the level of electrification in the whole province is significantly lower than in most provinces (NER 2000: 18).

In summary, this chapter will show that the determinants of household energy use in the Eastern Cape rural areas sample are:

- Limited access to appropriate fuels;
- The high cost of fuels and electrical appliances for poor households;
- Inefficient use of biomass fuels, particularly fuelwood;

- Indiscriminate harvesting of wood which contributes to environmental degradation; and
- Poor health and safety concerns associated with the collection and use of biomass fuels.

This chapter compares the energy end-use patterns amongst grid and non-grid-electrified and non-electrified households. It looks particularly at the major end uses, the fuel-appliance combinations and the quantity and frequency of fuel use. The aim of this comparison is to emphasise the importance of end-use analysis in household energy policy. It is clear that households use different fuel-appliance combinations depending on specific reasons. Therefore, an 'analysis of household energy use must be rooted in a sensitive approach, not only to issues of supply, but those of demand as well' (WEC 1999: 35). In addition, this chapter provides a critique of the supply-dominated approaches to energy policy at the household level. Contrary to popular discourses, it argues that multiple fuel-use is a permanent phenomenon in low-income households. Some of the hypothetical questions explored include:

- Why do low-income households switch more easily to electricity for media and lighting purposes than for other household uses?
- What impacts does access to electricity have on household livelihoods, security, education, etc? What are the corresponding impacts of not having electricity?
- What are the determinants of multiple fuel use or fuel backswitching?

4.2 The importance of transitional fuels for cooking

Almost 60% of the sampled non-grid electrified households use paraffin for cooking, as it is the most affordable and accessible cooking fuel (Figure 4-1). In addition, these households cannot use their SHSs for thermal applications as they are only limited to use of lights and media appliances. The associated costs for thermal end-uses prevent households from using electricity, thus leading them to use paraffin (DME 1998: 37). Paraffin is an affordable fuel to low-income households, as it can be purchased in small quantities, making it easier to ration and control the consumption (Williams 1994: 56).

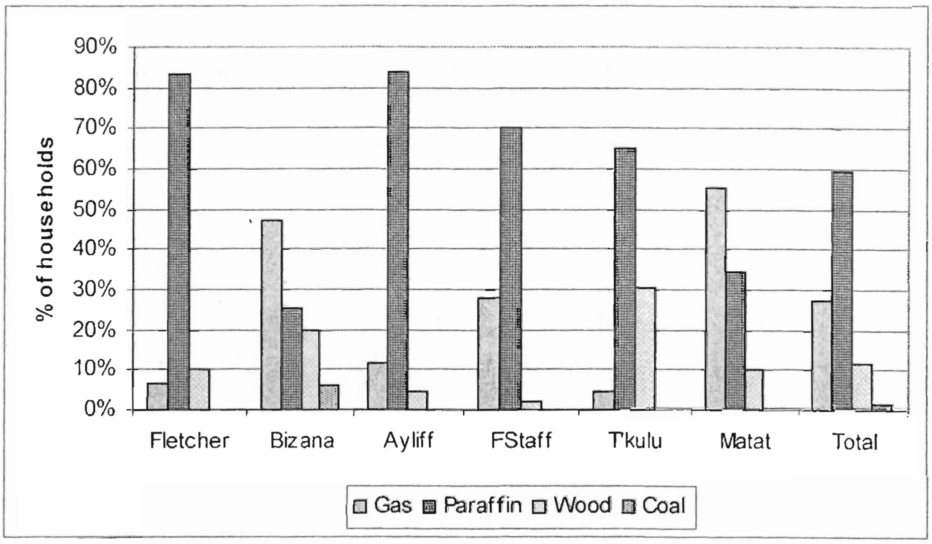

Figure 4-1: Main fuels for cooking in non-grid households[10]

The surveyed households purchased paraffin in different denominations ranging from one litre to 25 litres, depending on the disposable income of the households and on the specific end-use. A litre of paraffin costs at least R3.50 on average for all the areas surveyed, but when bought in bulk, (20 litres) it cost R58. The purchase patterns of paraffin illustrate the income flows of households in all three categories. It is safe to assume that households purchasing paraffin in bulk usually have regular and stable incomes (in this case these are non-grid and grid electrified households), while households with little or irregular incomes purchase paraffin in small denominations and often on daily basis (Figure 4-2). However, the latter households end up paying more for paraffin use. Households often buy small quantities of paraffin from spaza shops, but would go to town to buy in bulk where transportation costs would have to considered by the households.

[10] The percentiles shown in Figure 4-1 (and all the following figure) represent the households using different fuels for different end-uses.

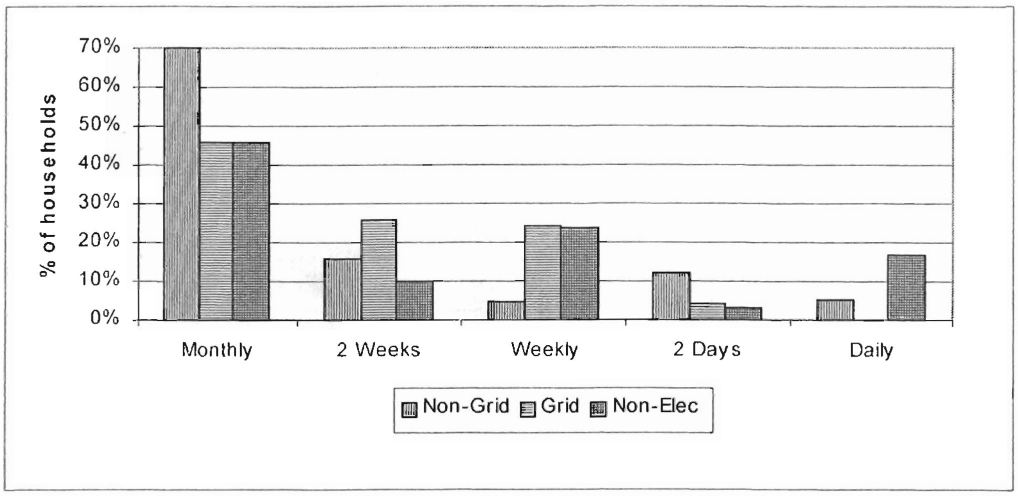

Figure 4-2: Paraffin purchase frequency for all households (%)

Figure 4-2 shows the number of times that households purchase paraffin. It is noticeable in the above figure that majority of households who bought paraffin in bulk were those supplied with solar PVs (70%). Grid-electrified households had an option of using electricity for thermal applications explaining why these households had lower frequencies in paraffin purchases per month. A significant number of non-electrified households bought paraffin on a daily (17%) and weekly (22%) basis. Among many other factors, these households had the lowest income levels in the sample (see Chapter 3, Figure 3-6) – which led them to buy fuels when there is disposable income to do so.

In general, gas was the second most used fuel for cooking in non-grid electrified households while a few also used it for water heating. In fact, in Bizana and Matatiele 55% and 47% of the non-grid households, respectively, used gas as the main fuel cooking (Figure 4-1). In these areas, gas supply is relatively good due to good transportation infrastructure. Given that the Eastern Cape province is one of the most impoverished rural areas in South Africa, the prevalence of a commercial fuel like gas was remarkable.

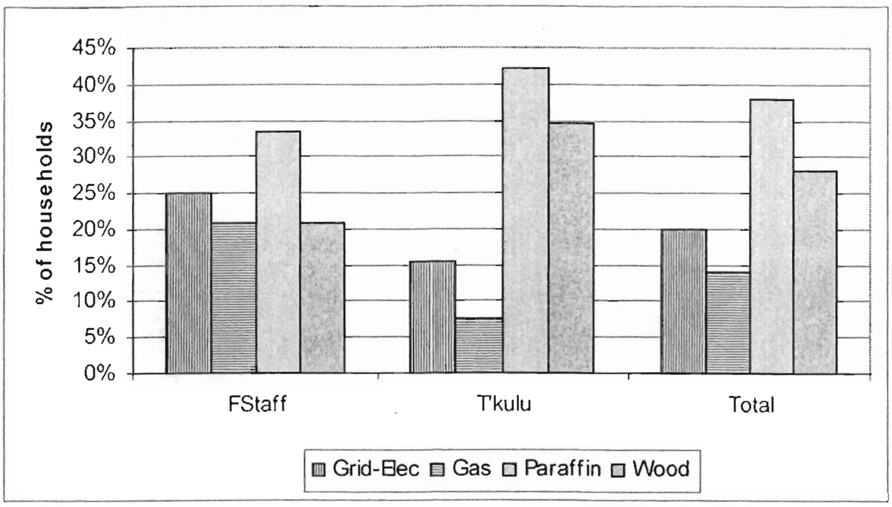

Figure 4-3: Main fuels for cooking in grid-electrified households

It is also interesting to note that the Eskom/Shell JV, which provides solar electricity to these households, did not trigger the use of gas for cooking, as the company did not supply these households with gas canisters. As part of the agreement with the government, the non-grid electricity service providers are expected to provide gas and paraffin to households, as part of the solar energy service package. These fuels are supposed to be sold in the energy stores of the service providers, located in the villages (National Electricity Regulator 2002: 6). The availability of these fuels will provide easy access for the customers and ensure affordability, as people living in these rural areas will not have to travel long distances anymore to buy fuels such as paraffin and gas.

Public transportation such as buses and taxis was used by households to go to the nearest towns to purchase gas and paraffin. Gas was preferred for cooking (in combinations with other fuels such as paraffin) in grid and non-grid electrified households whilst non-grid electrified households also used it for refrigeration (see Figures 4-1, 4-3 and Table 4-3). The 19 kg gas canister was popular, which cost about R92 excluding the canister deposit amount. Gas was mostly purchased once a month and there were no village-based outlets selling this fuel. This is the rationale informing the public-private partnership (i.e. the solar concession programme) – to provide gas in rural areas.

While the uses of paraffin and gas were most prominent in non-grid electrified households, these were not the only these fuels used for cooking. Households used various fuels for cooking depending on the food cooked (i.e. different fuels were used for hard and soft food also taking into consideration the time it takes for a particular meal to be prepared). Use of gas in these areas could be attributed to their close proximity to the main towns. Villages in Matatiele have an urban influence as they are situated near the 'town centre', which also provides employment opportunities. The villages in Bizana are also located near the town with a degree of urban influence. It is also the gateway for people travelling from the North Eastern parts of the Eastern Cape rural areas to urban areas such as Durban and Port Shepstone. Only 4% of non-electrified households used gas because of their apparent poverty as shown in Figure 4.4.

It is noticeable that paraffin use for cooking dominates in grid-electrified households (see Figure 4-3) irrespective of access to electricity (close to 40% compared to 20% that used electricity for cooking). Although electricity supply is meant to improve people's livelihoods, especially in the rural areas, the cost of use for cooking is prohibitive. The grid-electrified households, unlike the non-grid electrified, could use their electricity for thermal purposes, but only a small number of these households did. This can be linked to what people in the rural areas have expressed in the past regarding the costs of electricity compared to paraffin (Mohlakoana 2001). Households in rural areas have said that paraffin was more affordable than electricity for cooking, the cost of electrical appliances was prohibitive, paraffin appliances were multifunctional, etc.

Ironically, paraffin popularity did not mean it is a preferred fuel. Households use paraffin because it is affordable. While the current study did not explore households' views on paraffin, there is enough evidence in literature to suggest that it is not a fuel of choice (see for example, Williams 1994; Bank et al 1996; Mehlwana 1999a; Mohlakoana 2001). There is consensus that paraffin use is not 'healthy'; it contributes to respiratory diseases, eye irritation, paraffin poisoning, and makes food taste bad; the soot makes pots and walls dirty.

If people do not have employment and food, it could be difficult for them to prioritise their energy needs. While government is making efforts to ensure universal access to electricity, there is also a realisation that households do not use electricity to the optimum (see also Thom 2000: 36; Hansmann 1996: 31).

It is also evident that a large number of electrified households in Flagstaff (28%) and Tabankulu (35%) use fuelwood for cooking (Figure 4-3). These areas are situated 47 km apart, and there are woodlands on each side of the road. These woodlands are privately owned, and are harvested for commercial timber. Households adjacent to these woodlots have easy access to discarded timber that they use for cooking and heating. Some households purchase the fuelwood supplies.

For a majority of poor non-electrified households the main problem was the long distances often travelled to collect fuelwood. There were instances where women left their homes very early in the morning to collect firewood and come home late in the afternoon to prepare food for their households. The fact that these households depended on fuelwood, paraffin and other traditional fuels meant that their health was always at risk.[11] Figure 4-4 shows that non-electrified households (55%), depended highly on firewood.

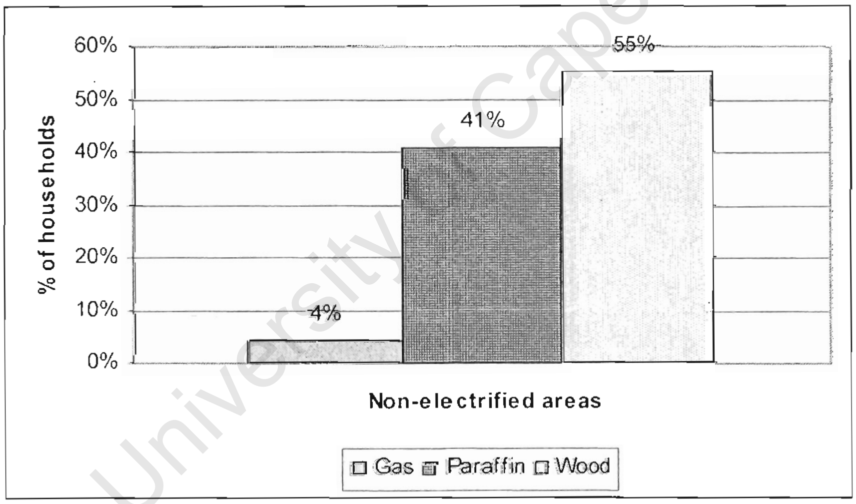

Figure 4-4: Main fuels for cooking in non-electrified households[12]

According to Figure 4-4, non-electrified households sampled the most prominent fuels used for cooking were paraffin (41%) and wood (55%). As Eberhard and Van Horen (1995: 53) note, 'geographical location of households in South Africa is a key determinant of their energy consumption patterns'; in areas where a specific fuel is in abundance, the majority of poor households would use that fuel. For instance, coal is used more in coal producing provinces; gas is used more in coastal areas; wood is used

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[11] See Mehlwana (1999a: 19-28) for health implications of transitional fuels including fuelwood.

[12] The non-electrified households represented on this figure only include those in Bizana as the sample of non-electrified households in Mt. Ayliff was too small.

more in forest areas. The non-electrified households surveyed had to travel long distance to obtain 'free' firewood and, as it is often the case, they resort to cutting down green trees or shrubs, as has been found out in the survey.

The patterns of cooking, as presented above, may appear to lend credence to the fuel transition theory. It argues that a total transformation to modernisation takes place when a traditional society changes from ancient to new forms of technology. Accordingly, modernisation occurs when the household use of energy is transformed from traditional biomass fuels through a series of transitional stages to electricity. Electricity is equated with modernisation and the use of gas or paraffin is viewed as a temporary stage following the use of biomass fuels.

On the contrary, the use of transitional fuels in these sampled households is permanent, irrespective of their access to electricity. Households were using multiple fuels and appliance-fuel combinations, which although linked to income, was partly because of the efficacy of the fuel in performing several tasks, or depending on the type of cuisine being prepared. The use of transitional fuels, especially amongst the non-grid electrified households, may remain the same because of the limited power supply of the solar home systems obliging households to use different fuels for different end-uses. Energy poverty studies have shown that low-income and poor rural households tend to use paraffin or fuelwood rather than electricity to prepare slow-cooking staple diets. Studies also reveal that households change their diets according to the amount of fuel they have or the type of fuels they have access to (see Annecke 1993; Ross 1993).

All the surveyed households in this study, irrespective of electrification status, aspired to 'modernity', that is, the use of electricity for cooking. This suggests that energy policies should not only aim at providing 'modern' energy services, but also to ensure that the services provided are affordable to the end users.

4.3 Importance of good lighting

Solar PVs have obviously made an instant impact on households using them – almost all non-grid electrified households used this energy source for lighting (Figure 4-5). These households paid a once-off installation fee of R150 and a service fee of R52 every month to the service provider (see Chapter 5 for households' perceptions on this fee-for-service).

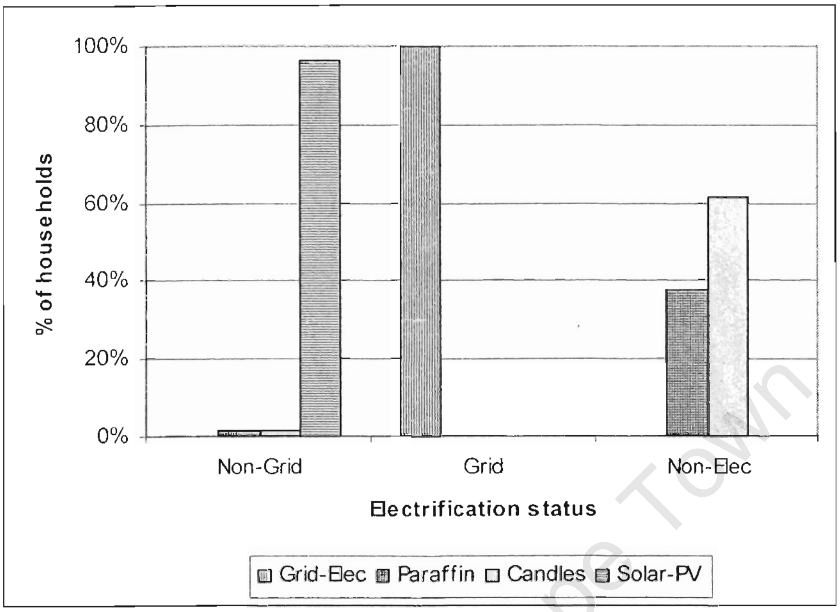

Figure 4-5: Lighting fuel for all surveyed households

These households signed a contract with Eskom-Shell JV to pay monthly service fee, failing which the system would be disabled and possibly confiscated. Defaulting households would be given a grace period, usually a month, to settle outstanding amounts (Horlock 2001). Households have an option of purchasing electricity cards from different outlets. Five of the sampled six areas had RESCO (Rural Electricity Supply Company) offices dealing with administration problems and households' applications for solar systems. Households could also purchase cards from these offices, or from various outlets located in the villages – established shops with which Eskom/Shell JV had contracted to sell cards. These shops also kept a 'complaints book' to record customers grievances about the systems.

The solar PVs were installed with four compact fluorescent lights (three inside the house and one outside). However, some households also used other fuels, particularly paraffin and candles as supplements for the lighting. These were homesteads, which comprised of more than two multi-roomed outbuildings. If they wanted to install more lights, households had to do so at their own expense. Another important reason for non-grid electrified households' use of candles and paraffin was that solar PVs have limited number of hours for lighting. This forced a number of households to use backup fuels in the event of a power cut-off. Households said that they were not happy about this and would like to have more hours for lighting (see Chapter 5).

All (100%) grid-electrified households used grid electricity for lighting (Figure 4-5). This suggests that switching to electricity for lighting is easier for households than switching to electricity for other end uses. The sampled households in this study showed similarities to a study conducted in rural areas of Limpopo (formerly known as Northern Province), which showed that all grid-electrified households used this energy source for lighting more than any other end-use (cf. Thom & Mohlakoana 2001: 3). Households would ensure that they had enough electricity for lights. Most said that they like electricity for lighting because of its brightness and would not be able to live without it.

Electric lights, whether households are grid or non-grid electrified, provide rural households with a new experience. At Maphephetheni, in KwaZulu-Natal, households were able to perform other activities at night because of superior lighting. Women were able to sew and make handcrafts and foodstuffs at night, and sell these wares during the day (Annecke 1998: 24).

Income group/category	*Average electricity expenditure per month*
R0-R600	R29.71
R601-R1 800	R30.00
R1801- R3 000	R30.00
R3 000+	R33.00

Table 4-1: Monthly electricity expenditure: grid households

Table 4-1 shows only slight difference in electricity units bought by grid-electrified households with different levels of income. The similarity in the purchase of electricity, and the fact that these households purchase an average of R30 electricity per month (equivalent of about 78 kWh per month), suggests that these households use electricity primarily for lighting and media purposes. For thermal applications, most households (about 80%) would purchase non-electric energy sources.

The grid-electrified households purchased prepaid cards from Eskom electricity vendors. The level of community satisfaction with this arrangement was high. Most of the surveyed electrified households found these electricity outlets accessible. Only a handful of households complained about their limited operating hours (this is further explored in Chapter 5).

Elec. Status	*Always*	*Sometimes*	*Never*
Non grid	**54%**	**39%**	**7%**
Grid	**81%**	**19%**	**0%**

Table 4-2: Percentage of grid and non-grid electrified households using of electric lights for studying

The impact of grid electricity was obvious and emphatic. Compared to non-grid households, it was found out that 81% of grid-electrified households used electricity to study at night or to do homework. Electricity provides better quality illumination than candles or paraffin lanterns thus making it easy for people to study at night. In non-grid electrified households, the figure was only 54% (as illustrated in Table 4-2). This was due to the fact that non-grid electricity use is limited to a certain number of hours meaning that households could not use it for long when studying at night.

About 61% and 72% of non-grid and grid households respectively mentioned that electricity increased the number of hours of doing homework (cf. Thom and Mohlakoana [2001] for the impacts of electricity on education in Limpopo Province). Although this does not mean that better lighting leads directly to high education levels, it is an indication that having electricity for lighting does contribute more time for doing homework or studying amongst school learners.

The main source of lighting in non-electrified households (62%) was candles as shown in Figure 4-5 followed by paraffin, which was used by 38% of the households. As mentioned in Chapter 3, non-electrified households had lower incomes, meaning that their expenditure on fuels was determined by the amount of disposable income they had access to at a particular time.

While grid and non-grid electrified households used candles as backup in the case of electricity blackouts, or to illuminate rooms not connected to electricity mains, most non-electrified households depended on candles for lighting on a daily basis. A candle cost at least 82cents whilst a pack of six candles on average cost R4.74 and provided low illumination of six to eight hours per candle. More households purchased candles on a monthly basis. Paraffin in non-electrified households was mostly used for cooking, showing that income levels of households play a role. If these households had more income, there would have been more use of gas or other more convenient fuels for cooking.

Candles are often associated with danger as they contribute to residential fires in urban low-income areas (see Mehlwana & Qase 1998; Bank et al 1996). In urban areas, the close proximity of the settlements to one another probably precipitates fires spreading in these areas. While incidences of residential fires are rare in rural areas – and indeed there were no reported cases at the time of research, this does not mean that the fires cannot happen because of a dislodged candle.

Data generated from the present study shows that 99% of non-grid electricity users would like to switch to grid electricity for lighting. The quality of lighting plays an important role; households in other rural areas have expressed a preference for electricity for lighting, since it is brighter than candles or paraffin lamps (cf. Thom and Mohlakoana 2001: 3).

4.4 Fuels used for space heating

Results from the surveyed areas show that these households irrespective of their electrification status used mainly wood and paraffin for space heating (Figures 4-6, 4-7 & 4-8). This was because non-grid electricity has low load output, and consequently does not allow for thermal applications. On the other hand, grid-electrified households could not afford the costs of using electricity for space heating due to expensive appliances and high running costs. Open fires, especially when prepared indoors, contribute to poor air quality for people exposed to it. As a result, more people are at risk of contracting respiratory diseases. There seems to be a need for efficient wood stoves, as winters in these areas are severe.

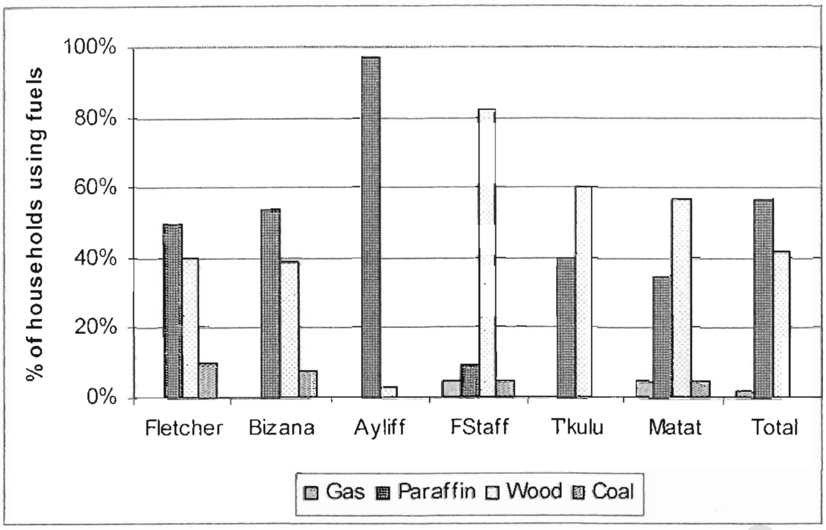

Figure 4-6: Main fuels used for space heating in non-grid electrified households

Figures 4-6 and 4-7 show the main fuels used for space heating by non-grid and grid-electrified households. As mentioned earlier, the non-grid electrified households use fuelwood and paraffin mainly for this purpose because of the limitations of solar PVs for thermal applications.

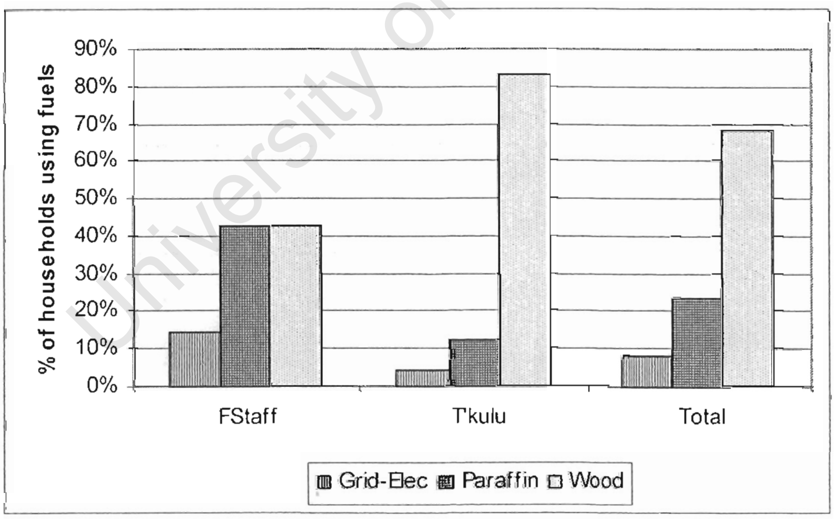

Figure 4-7: Main fuels used for space heating in grid-electrified households

For grid-electrified households it is expensive to use grid electricity for space heating, as it needs special or dedicated appliances, such as electric heaters. Households would rather purchase an electric stove than an electric heater (see Mehlwana & Qase 1998: 40).

Only 8% of grid-electrified households (Figure 4-7) used electricity for space heating versus 20% of these households that used it for cooking (see Figure 4-3). The main reason is that electric heaters are not as versatile as non-electric heaters whereby a paraffin or a gas heater could also be used as a cooking appliance this is impossible with an electric heater. Wood and paraffin were the most used fuels for space heating because these fuels simultaneously performed other uses, such as cooking and even providing illumination.

Fireplaces, whether inside or outside, were used for cooking, lighting and space heating, thereby lowering energy costs. It is nearly impossible to do this with electrical appliances, as they are dedicated to only one end-use.

It is also noticeable that 14% (Figure 4-3) of the grid-electrified households used gas for cooking and none used it for space heating as shown in figure 4-7. The high costs of gas heaters militate against the use of this fuel for space heating, as they are more expensive than basic electrical, paraffin and wood heaters. The use of coal in these areas of the Eastern Cape is also very rare, especially amongst the households surveyed. This is because these rural areas are located far from the coalfields, making it difficult and expensive to transport and use this source of fuel.

Figure 4.8 shows that 73% of non-electrified households used wood for space heating, indicating that this was the main energy source for these households, especially in winter. It must be kept in mind that these households were the poorest in the sample. As illustrated in Figure 4-4, these households (55%) also used wood for cooking. The number of non-electrified households using gas for space heating was low (3%) which is almost similar to the number of households (4%) using this fuel for cooking denoting the impoverished status of these households.

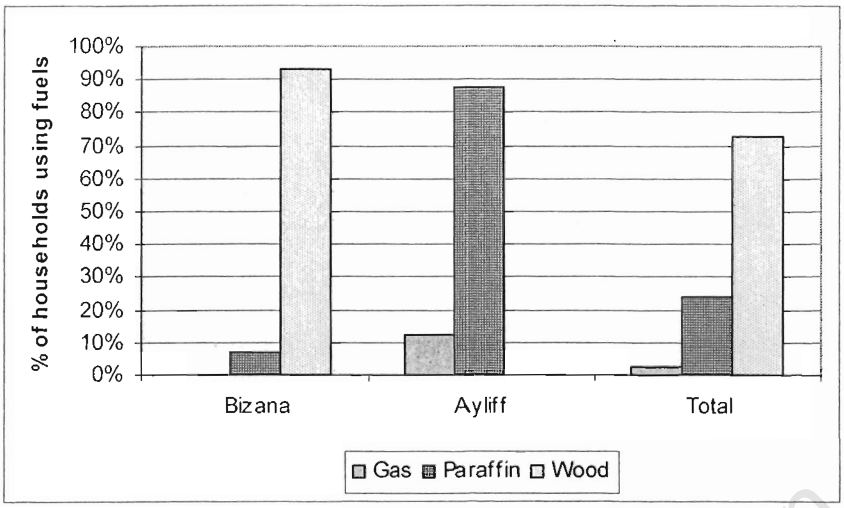

Figure 4-8: Main fuels used for space heating in non-electrified households

As paraffin and gas are commercial fuels, the affordability of these fuels dictates how households use them. Using wood for space heating in non-electrified households is more affordable, especially if the fuel is freely available, as it can also be used for cooking purposes. The over-reliance on fuelwood meant an additional burden on poor women from poor households considering the long distances they had to walk when collecting fuelwood.

4.5 Refrigeration and its impacts on livelihood strategies

Table 4.3 shows fuels used for refrigeration. Although refrigeration is an important end-use for rural households, very few households in the sample owned or had access to refrigerators. The very low ownership of refrigeration in non-electrified households could be associated in part with the lack of a suitable energy source and in part with extreme poverty. One would have, however, expected at least a higher number of refrigeration in grid-electrified households, yet only 26% of households had these appliances. The irony is that more non-grid electrified households had more refrigerators than grid-electrified ones.

Categories	*Electricity*	*Gas*	*Paraffin*	*Car battery*	*Petrol*
Non grid	1%	82%	0%	4%	13%
Grid	92%	0%	8%	0%	0%
Non electrified	0%	100%	0%	0%	0%

Table 4-3: Percentage of households using different fuels for refrigeration across the sample

In the sampled households, 34% of non-grid electrified households owned refrigerators and 25% of the grid-electrified households also owned refrigerators. Only 5% of the non-electrified households owned refrigerators due to the lack of fuels to use and money to purchase these appliances. It is worth mentioning here that ownership of refrigeration appliances does not mean that households necessarily use them due to lack of appropriate energy sources. Some of these appliances were not purchased by these households but were given to them as gifts, thus one may find a non-grid electrified household with a refrigerator that is suitable for grid electricity use.

Refrigeration was cited as one of the major necessities for the households, as it is closely tied to households' livelihoods. It plays a significant role in improving households' lifestyle and nutrition. Households purchase easily perishable food in bulk and store these for longer periods. Bulk-buying of foodstuffs also had positive impacts on households' budget. For many poor rural households, the inability to buy essential foodstuffs in bulk means that they have to spend more money in buying single items. They cannot purchase essential items such as meat, milk or vegetables in bulk as these would spoil quickly because of heat depriving them of proper nutrition.

Apart from improved nutrition, health and reduced household expenditure on food, owning and using a refrigerator could be the major supplement of households' income through the sales of items such as meat, milk, cool-drinks, etc. This could also contribute to small business development in the rural areas.

4.6 Energy for media use

As shown in Tables 4-4 and 4-5, most households – irrespective of electrification status – owned and used media appliances. Radios appeared to be most popular entertainment appliances. As with lighting (Figure 4-5), non-grid and grid-electrified households find it easy to convert fully to electricity for use of these appliances. Almost all electrified households had either a radio or a television or both. This cannot be ascribed to the question of economics or affordability alone.

Categories	*No radio*	*Electricity*	*Car battery*	*Dry Cells*	*Solar*
Non grid	16%	0%	4%	14%	66%
Grid	48%	40%	0%	12%	0%
Non electrified	58%	0%	4%	38%	0%

Table 4-4: Percentage of radio ownership across the sample and types of energy used

Categories	No television	Electricity	Car battery	Generator	Solar
Non grid	36%	0%	9%	2%	53%
Grid	55%	43%	2%	0%	0%
Non electrified	82%	0%	18%	0%	0%

Table 4-5: Percentage of television ownership across the sample and types of energy used

Televisions, in particular, are expensive appliances, yet most households would invest in these rather than thermal appliances. Indeed, as Mehlwana (1999b) notes, upon electrification, poor households would invest in lighting, radio and televisions first, rather than in stoves or refrigerators. He argues that these appliances are 'symbols of modernity and comfortable existence, and many [poor] people will go to extremes in order to acquire them' (Mehlwana 1999b: 9; see also Thom & Mohlakoana 2001: 3). This is a phenomenon, which has been noted in many other countries (see Nieuwenhout et al 2000).

A significant number of the sampled households, particularly in the grid and non-grid categories owned sophisticated appliances such as colour television sets and music centres, which were obviously more expensive than small and cheaper radios and portable black & white televisions. Some writers (e.g. Annecke 1993) associate this with gender relations in the households. Women are said to prioritise cooking appliances while men are likely to prioritise media appliances. Although this may appear to be the case, it was not fully explored in this research. It is important to note, though, that appliance acquisition is determined more by who holds (economic) power in households than by the gender of the purchaser. Many women have decisions making powers, and in the case of this study, a significant number of households are female-headed; moreover, women contribute financially in the running of their households. Hence they also purchase radios and televisions, because these appliances are more popular across the gender divide.

With media, there is a close correlation between energy sources used and households' electrification status. On the one hand, non-grid-electrified and grid-electrified households used electricity to power most of their media appliances (Tables 4-4 and 4-5). On the other hand, non-electrified households depended either on dry cell or car batteries. It was noted that some households in the non-grid category owned colour televisions that could not be powered by solar PVs because of low power output of SHSs. These households would use petrol generators to power them. It was also noted that there were grid-electrified households that used car batteries and dry cell batteries for their radios and televisions. This was mainly because of the frequent power cuts that forced these households to have non-electric fuels as backup. Another reason was that radios that use dry cell batteries are more portable, allowing people to move them around within their homesteads. For the reason that they were mostly poor and lack access to better energy sources, non-electrified households only owned battery-powered appliances. According to figures in Table 4-4 above, 38% of non-electrified households owned small transistor radios. These radios are cheaper than music centres and colour televisions.

Owning appliances is not the same as using them, as it was revealed. Other studies also make this important distinction (see for example, Simmonds & Mammon 1996: 59). Appliances, especially televisions, are more significant not only because of their use, but also because they serve a decorative or symbolic purpose (Mehlwana & Qase 1998: 45). However, in this case, it appeared that the unavailability of appropriate energy militated against the use of these appliances. For instance, a significant amount of households in non-grid electrified areas owned colour televisions, but could not use them because they do not have sufficient electrical power. Solar PVs do not have sufficient power for large colour televisions.

4.7 Conclusion

This chapter has demonstrated that the determinants of households' energy use include the extent of access to appropriate fuels, cost of fuels and appliances, and harvesting of wood. Safety and health concerns associated with collection and use of biomass fuels also determine how these households use energy. This chapter has also reaffirmed the widely held wisdom in energy and development discourse that households are less interested in 'cutting edge' energy supply options and more in the service that such options provide. As long as this is the case, households will continue to switch between fuel-appliance combinations, and use a range of fuels for one end-use, depending on the efficacy that each fuel provides, as well as interplay of other reasons. Rural households rely on 'traditional' and 'transitional' fuels for heating and cooking even if they have electricity.

Despite the critique of the electrification process, this chapter has also shown the positive impacts of electricity on households' livelihoods. On the other hand, non-electrified households have limited energy options and have to rely on potentially hazardous fuels such as candles. Security is the main concern in rural and urban areas of South Africa. Electrical lights have brought a sense of security at night. Non-electrified households do not only deal with entrenched poverty and use of 'inferior' fuels, but they also live in danger of not having bright lights in and around their homes.

The chapter has touched on the issues of cost and affordability notions as the major drivers of household fuel use. Lest this be construed as an uncritical affinity with the energy transition model, with its emphasis on the economics as the main and probably the only significant drivers influencing fuel switch, the chapter recognises that fuel switch and substitutions are not simple phenomena. In recognition of the complexities of household fuel use patterns, this chapter has referred to studies which examine qualitative notions such as gender, preferences, appropriateness of certain fuels, local traditions or socialisation, as well as quantitative determinants such as education, geography, fuel availability, etc.

Notwithstanding, it is recognised that an overly quantitative analysis has inherent limitations because of its tendency to 'objectify' fuel use, and the conscious or unconscious isolation of household energy use patterns from the broader social processes. This analysis may have therefore reduced household decision-making processes on fuel into simplified neo-classical notions of 'cost and affordability'. Nevertheless, the strength of this chapter is to also show that it is possible to employ quantitative data to extrapolate the complexities of household energy, as much as one could do with qualitative data. In conclusion, the issues that this household energy analysis raise and which arguably have wider implications than the narrow confines of this chapter are presented below. These issues are a) the sustainability of solar home systems and the efficacy of these electrification options in addressing South Africa's rural poor energy poverty; b) the permanency of transitional fuels; and c) the inadequacy of electricity supply based solutions.

A question should be asked about sustainability of solar PVs as the substitute for grid electricity in rural areas.[13] Firstly, the solar PVs, as shown above, are only fitting for

[13] Wade (1997) argues that after more than 15 years of seriously attempting rural electrification through PVs, it still remains the insignificant part of the existing development of rural electrification on a global scale. He argues, '...to a greater extent, the problem has been the lack of understanding

lighting and providing power for some media appliances. Furthermore, the services that solar PVs offer are more expensive than grid electricity. Why should households pay R52 for lighting and media while they could pay significantly less for the same services if they had access to grid electricity? The grid-electrified households were found to spend less on electricity than their (non-grid electrified) counterparts.

Secondly, payments towards the services of non-grid electricity are rigid, irrespective of the amount of energy used in that particular month.[14] Households would find it difficult to sustain payments over a long period. Thirdly, solar electricity has a limited period of use in hours. What if households want to use electricity for more than the stipulated hours? As indicated above, a significant number of households owned electrical appliances such as televisions that have high load demand. These televisions could not be used because the solar systems cannot accommodate them. Would not this lead to the perception that non-grid is a poor third-rate energy source? Fourthly, and more importantly from a development perspective, only those that can afford a monthly fee of R52 could be supplied with solar systems, meaning that this intervention is definitely not targeted to the majority of poor households. Lastly, South Africa has a very active national grid-electrification programme. How would households choose non-grid, which is obviously inferior, when there is a possibility, albeit remote, for grid extension?[15]

The chapter confirmed that the so-called transitional fuels are permanent phenomena in low-income households. Candles, paraffin, fuelwood and gas will dominate household fuel use patterns well into the future. It is a dream that the provision of electricity can

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by development officials and particularly of marketers as what rural people want. In short, it is largely a misdirected marketing programme. In fact, marketing efforts are often directed at selling PV systems instead of selling the electrical services, which is what rural people, really want' (Wade 1997: 1).

14 Flat rate tariffs were found to be unpopular in Tambo village, Eastern Cape, in an Eskom pilot study. In this village, Eskom was piloting with a limited supply option (2.5A). This project failed not only because 2.5A proved to unpopular; it failed because households in the area could not sustain the payment of the flat rate tariff, which was R15 per month (see James & Ntuthela 1997, James 1997).

15 However, areas in the Eastern Cape, where non-grid systems were installed, are less likely to get grid-electricity in the next five to ten years, hence the non-grid concessionaires were given these 'permission areas'. Furthermore, households provided with grid electricity are unable to use this supply to the optimum because of various reasons. The bottom line is that the rural households in the Eastern Cape are regarded as, and are amongst the poorest areas in the country. Therefore, service repayments will always be a problem, irrespective of technologies disseminated.

lead to complete fuel substitution. Granted, as the chapter has demonstrated, electricity has made significant inroads in the use of entertainment appliances and lighting. However, this transition is not complete. Households still use or keep non-electric fuels as backups for the very same end-uses. Furthermore, the use of electricity for these end uses is less energy intensive than for thermal applications such as heating and cooking.

This then calls for widening of access to non-electric fuels such as paraffin and gas. The former in particular is viewed as the energy for the poor; hence, the government is treating it as a basic need and has, like bread and milk, zero-rated it. However, the reality is that this popular fuel is very expensive, especially at the end of the long distribution chain or the spaza shop level, where the very poor source their paraffin. Some writers propose shortening the paraffin chain so that it would benefit the poor, but the other implications of reducing the chain need to be considered seriously. What is going to happen to households or spaza shops that depend on paraffin sales for income? What would happen to credit relationship between these paraffin micro retailers and the very poor households?

Lastly, this chapter revealed that the end-use analysis is useful in that it shows the inadequacy of electrification-based solutions in addressing rural energy poverty. Many studies reveal that electricity is not a panacea for development. There is little evidence elsewhere that electricity in itself creates income-generating opportunities in rural areas. Electricity is a necessary but not sufficient component of development. It is often mentioned that electricity connections in rural areas do not even cover the operational costs.[16] Households may have access to this energy source, as demonstrated above, but would not use it optimally. There is therefore a need for an approach, which would pay more attention to the energy services rather than the number of electricity connections, or how many renewable energy supply options have been disseminated.

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16 Banks et al (2000) estimate the 20-year net present value (NPV) of rural electrification connections to be negative R5 800.

CHAPTER 5:
Electrification-driven approach vs. needs-based approaches to development

> Any interventions using technological innovations must be introduced in consultation with households, for the simple reason that without this input households are unlikely to use them (DME 1998: 38).

5.1 Introduction

This chapter compares the service delivery issues that grid-electrified and non-grid-electrified households experienced in the sampled households. It also explores how the 'local understanding' of different electricity delivery methods affected and influenced non-electrified households' perceptions about electrification. The chief aim of this is to argue that sustainable energy development *cannot* be achieved by focusing only on supply issues, such as the number of households connected to the national grid or supplied with solar PVs. Long term development occurs through paying careful attention to the development needs of households. This chapter builds on previous chapters and argues that 'demand-side issues' do not only have theoretical relevance, but should also be considered in practice.

This thesis also explores the theoretical underpinnings of supply-oriented electrification options. It argues that while it is commonly accepted in energy discourse that electricity supply-driven solutions often do not bring intended results; this wisdom is often ignored in practice. Non-grid electrification options such as the solar home systems (SHSs) are often introduced to households without really paying attention to demand-side issues and development needs of the intended beneficiaries. Put simply, what rural households need is electricity for cooking, water and space heating, ironing and refrigeration. Section 5.3 provides a glimpse of the broader national electrification policy and strategies, particularly for rural areas. This section provides a context within which the non-grid intervention in the Eastern Cape is placed in a national perspective. Section 5.4 presents the perceptions of households on grid and non-grid electricity supply options.

Section 5.5 exposes the plight of 'future' grid or non-grid electricity customers, speculating on their responses to grid and non-grid electricity options – that is, households that do not have the choice of either electricity supply option. It must be realised that an important category of households are entirely excluded from the debate such as those excluded from the choice of either electricity supply option.

5.2 Electrification options versus needs approach: theory and practice of sustainable energy solutions

According to current development theory, development is said to be sustainable if it is holistic and encompasses social, economic and environmental concerns. Sustainability is also about meeting the current generation's needs without compromising the needs of future generations. The goals of development are to achieve social equity, economic efficiency and environmental sustainability. These goals are achieved through the utilisation of bottom-up approaches, which ensures local participation in development planning and implementation. Intrinsically, this notion of development lays emphasis on context uniqueness and specificities as major drivers of development. Many 'development' initiatives and strategies have not produced intended benefits: poverty and perpetual dependence in the rural areas are commonplace.

Until recently, household energy use issues and policies were more concerned with increasing the supply of energy. These policies largely failed because they did not link energy supply issues with other components of development (Eberhard & Van Horen 1995; Sokona & Thomas 1997). They paid less attention to end-uses for which energy is used. Barnett et al (1982) argue that the knowledge about energy supply and related technology far exceeds the knowledge about the problems, which the electrification option is supposed to solve. For instance, they argue that the insufficient knowledge about rural 'energy development needs' is a major cause of the difficulties experienced in the diffusion of renewable energy supply options in rural areas.

Much analysis of energy and development is based on the 'transitional model', which is firmly entrenched in the modernisation theory as discussed in Chapter 4. Modernisation theory, as discussed, is discredited in the development discourse as ethnocentric and irrelevant in explaining (and providing solutions to) underdevelopment in rural areas. The transitional theory explains fuel change or substitution in the same manner as modernisation theory explains societal change. In summary, the model assumes a transition of energy use from 'traditional' fuels (biomass fuels) through various phases to 'modern' fuels (electricity). The phases in-between are characterised by the combined use of traditional and commercial fuels. This stage of 'adaptation' to modernity (full electrification), where households use multiple fuels is called a transitional stage. This assumption is criticised because of its 'simplicity and intuitive appeal' (Eberhard & Van Horen 1995: 66; see also McGregor 1992; Ross 1993).

It is worthwhile to isolate some of the assumptions and glaring omissions of the transitional theory as applied to rural contexts. Firstly, the transitional model is silent on sustainability in the use of new energy forms. Sustainability in energy in this thesis is defined broadly to include the ability to use and supply energy for a longer period so as to provide for future generations, as well as the willingness and ability to pay for the end-use. There is an assumption that a mere provision of new forms of energy brings development, but this is not borne out by empirical research. Studies show up the failures of energy delivering strategies that do not take into consideration sustainability issues (see Nieuwenhout et al 2001).

Secondly, similar to the world system theory of modernisation, the transitional paradigm ignores the specificities and complexities of the 'rural energy problem'. Energy in itself is not development, but becomes important only if integrated with other rural development needs, such as health, water and sanitation, agriculture, employment, and education (see Eberhard & Van Horen 1995). Again, the developmental needs of a given rural population are shaped by factors such as socio-political institutions or organisations, local administrative systems, economic profiles and power relations at the household and community level.

Thirdly, the transitional model is supply-driven and does not give a rounded understanding of energy end-uses. The diffusion of new forms of electrification is seen as the best strategy to deal with energy poverty – defined narrowly as the use of traditional fuels. The implied assumption is that the demand for new forms of energy 'is there' and the logic dictates an increase of supply to meet such demand. The danger of not paying sufficient attention to energy end-uses leads to the identification of wrong policy choices and intervention strategies thus leading to improper implementation of development programmes. The energy literature has many examples of energy technologies, which do not conform to the users' expectations and situations, one example being the GEF's solar PV project in Zimbabwe (see Mulugetta et al 2000). In this project, about 7500 solar photovoltaic systems were installed in rural areas from 1993 to 1997. Although the equipment was manufactured locally to lower the costs for the potential customers in terms of realising development goals, this failed, as the bias was towards those richer, high and middle-income rural communities that could afford repayments of loans (Ndlovu 1998). Nieuwenhout et al (2000: 23) provides a useful analysis of failure of solar technologies to address energy needs of the rural households in developing countries. They write that the most concerning factor is that the users would not sustain interests in solar technologies, because of poor performance and technical problems.

Lastly, the transitional paradigm is strictly product-driven or 'hard issue'-oriented, with little attention paid to the process (such as customer care and knowing what the needs of these customers are) of delivering energy services. In development discourse, the process is as important as the product. The failure to address how energy is delivered has resulted in strategies missing their 'targets' (the poor and, usually, women). Chapter 3 of this thesis has shown that the poorest households in the sample were non-electrified and up to 57% of these households were female-headed and had the lowest incomes compared to the non-grid and grid electrified households (see Figures 3-1 & 3-6). Many beneficiaries of rural solar PVs are not the very poor, but the better-off layers of rural populations. This can be confirmed by the fact that all the non-grid electrified households surveyed were required to have a form of monthly income so as to qualify for a SHS.

While much of the contemporary literature distances itself from the transitional paradigm as well as its analysis and prognosis, it is interesting to note that such thinking is still found. The rationale for many non-grid electrification projects clearly shows this line of thinking. Many studies express the positive virtues of non-grid energy in providing not only cost-effective energy, but also its *potential* role to aid sustainable development (Best 1992: 25-29). In discussing barriers that militate against the diffusion of non-grid electricity supply options, supply-oriented factors such as lack of information, institutional and administrative capacities, manufacturing capacity, etc. are more emphasised than demand-side factors. According to Farinelli (1999: 3), the energy sector is not fully transformed, as supply issues still dominate. Most 'innovative' renewable programmes are market-driven, and geared towards selling PV systems than the services. The demand-side approach stresses the end-use preference based on quality, affordability, reliability, safety, environmental impact and accessibility in energy provision. The demand-side focus identifies wrong problems and strategies (Tinker 1992; Smith 1998).

5.3 The non-grid energy policy in the context of national electrification programme

South Africa has one of the most active national electrification programmes in Africa. The country's *White Paper on Energy Policy* commits the government to provide access of electricity to all households in South Africa, irrespective of geographical location. Over the last few years, emphasis has been on addressing energy inequities in the former homelands, as these were the most disadvantaged areas in the past in terms of service delivery, particularly electricity. At least 49% of rural households are connected to the national electricity grid currently (NER 2001: 26). Banks (2000) argues that approximately 1.8 million people will still be without access to grid electricity by 2012. Extending grid electricity is proving a difficult challenge as it becomes more expensive to distribute electricity in mountainous areas with dispersed settlements. For instance, the current electrification backlog in the Eastern Cape stands at 610 623 with only 49 000 connections made in 2001 at the budget of R133 million (Mlambo-Ngcuka 2002: 2).

Most rural households will not have access to grid electricity in the short-to-medium term because they are situated far from the national grid. These households have limited choice but to use traditional biomass fuels and so-called transitional fuels such as paraffin and gas (for those that can afford them). In response to this state of affairs, the 'concessions programme' was conceived, with government allocating subsidies to companies that are able to install non-grid electricity (solar PVs) in areas that would be unlikely to be connected to the grid in the next five to ten years. These areas, of which the research area is part of, are known as 'permission areas'. Here it is guaranteed that Eskom will not extend its electricity grid within a five-to-ten year period. With this provision, a SHS is installed at a fee of R150. For each installation, the service provider receives R3 500 from the government. Failure by a service provider to provide services to the households after receiving the subsidies would lead the government demanding back a percentage of the subsidy given (NER 2002: 7). The non-grid service providers are also expected to provide other energy services to the rural areas where they are installing SHSs, such as selling paraffin and gas to make these fuels more accessible and affordable to the rural households. Ideally these fuels should be delivered to households to avoid the large transportation costs (and time) born presently by the households.

5.4 Non-grid and grid electrification in practice

The Eskom/Shell JV could be seen as a pioneering project in South Africa that attempted to provide solar energy in an integrated manner, even before the government began to formalise or systematise non-grid electricity solutions for household use. Households paid an installation fee of R150, and thereafter paid R52 per month for the service.[17] For households to qualify for this service, they had to receive regular incomes, such as pensions or wages. The SHSs installed have a power output of 50Wp which provided power for three inside lights, one outside light, three plug-and-play points for the radio, a black and white television and smaller DC appliances like cash tills.

The R52 paid by the customers every month gives them access to electrical power for the whole month. If they did not purchase the 30-day card that enabled them to use the electricity supply, systems would disconnect automatically, unless they settled the outstanding amount. In practice, this meant that if a customer was behind in payments for two months, she/he had to purchase two cards amounting to R104 to be able to reuse the system. Even if the customer did not use the power for the period of 30 days, she/he had to pay the R52 service charge. However, if the SHS was not paid for because it was faulty, the customer would obtain a credit from Eskom/Shell for the number of days the system was not in use. The Joint Venture provided maintenance services such as ensuring that the system is working at all times, replacing lights, extending wires for lights (however, this must not exceed the four lights provided), maintaining the battery water level and cleaning the system (Eskom/Shell JV: 2001).

The grid-electrified households had 20A systems installed in their homes. The installation cost between R65 and R150 in 1995-2001. This was part of the national electrification strategy. Households provided with grid electricity, unlike their non-grid electrified counterparts, do not have to pay a flat rate tariff to be able to use electricity.

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[17] While the Eskom/Shell JV project is currently part of the concession programme, it is worth noting that when this project started, it operated without government subsidies. In a way, this may explain the relative high costs of non-grid services.

The pre-payment system allows them to purchase electricity for whatever amount they can afford at a time. As reported in Chapter 4 (Table 4-1), these households normally purchased electricity for an average of R30 per month, much lower than non-grid electrified households. More importantly, they are able to use almost all household appliances with it. Unlike non-grid electrified households the purchase price for grid-electrified households was only for credit units. Households replaced their own lights or extended electricity to other rooms or dwellings at their own expense.

How then, did householders perceive the services rendered by these two extremely dissimilar supply options? Below is a discussion on households' subjective views about electricity services. Issues discussed here are people's perceptions on a) location of the system in the home, b) ownership of the systems, c) contractual agreements, and d) existing payment options.

Location of the electrical systems

Most of the non-grid electrified households had their solar home systems located by the installer in the lounge of their dwellings. Most households preferred their systems to be located in their bedrooms, kitchen or lounge so that they could monitor them. They wanted their batteries and plug points where they could have easy access to them (Table 5-1) and at the same time, guard them against theft. Households would pay a heavy penalty if the service provider found evidence of tampering with the SHSs.

	Location			*Level of satisfaction*	
	Lounge	*Kitchen*	*Bedroom*	*Satisfied*	*Dissatisfied*
Non-grid households	**65%**	**6%**	**27%**	**97%**	**3%**
Grid households	**35%**	**25%**	**39%**	**98%**	**2%**

Table 5-1: Percentage of grid and non-grid electrified households that expressed their levels of satisfaction on location of systems in their homes

Similarly, a number of the sampled households in grid-electrified areas wanted the meter/ ready-board to be within reach for easy monitoring and access to plug points. A few households would like to protect their systems against children tempering with them. Table 5-1 illustrates where the systems were located and customers' levels of satisfaction with the present arrangement. Both grid and non-grid electrified households were satisfied with the location of their systems. A reason for this was that households were given a choice of where the system should be placed.

For the non-grid electrified households, it was the choice of Eskom-Shell JV to place the solar panels on poles outside the houses. The system and a battery are safely secured to prevent tampering and theft. People are prohibited from opening the covered battery. Should they do so, the system would automatically shut down, cutting off power. Households were also provided with manuals written in four local languages, on how the systems work. In grid-electrified households, the meter and ready-boards (with plug-points) are located in rooms that householders prefer them to be. Just like non-grid electrified households, these households purchase cards to ensure that they have electricity supply in their homes and these are loaded onto these ready-boards.

'We want to own our solar systems': The effects on non-ownership

The contractual agreements required non-grid electrified customers to pay R52 service fee every month as long as they were in possession of the SHS although many of these households indicated that the price of solar cards was expensive. They were not given the choice to purchase the SHSs. On the other hand, grid-electrified households were not under such obligation of paying R52- every month whilst they were in possession of a solar system. They only purchased cards to use their electricity supply as they wished. After the installation, they do not pay any fixed costs, and pay extra costs only if they tamper with the ready-board/meter. Whether households purchased electricity tokens or not was totally up to them.

Owning the systems for the non-grid electrified households would mean that responsibility for maintaining the systems would fall upon the households. Experience elsewhere shows that households owning their SHSs find it difficult and expensive to maintain them. In some instances, these households would purchase 'cheap' components, which were not compatible with their SHSs. In Kiribati, households found it difficult to repair the systems because repair outlets were situated in towns far from the villages (Nieuwenhout et al 2000: 25). One disadvantage of buying the SHS is that after investing money in purchasing the systems, many households would find it difficult to invest more resources in the maintenance of the system. Under the fee-for-service arrangement, the SHS in principle should be properly maintained as long as households pay the monthly service fee.

Disagreements over contractual agreements

All of the non-grid electrified households entered into contracts with Eskom/Shell JV on receiving the SHSs. Table 5-2 illustrates the percentage of households that knew they had signed contractual agreements with Eskom/Shell JV and those that did not know what they had signed[18]. Most households admitted that they were not aware of the implications of the contract when they signed the application forms. In Mt. Fletcher and Matatiele, 41% and 48% of the households respectively said that they did not sign contracts with Eskom/Shell JV. The contract clearly states that '...systems shall remain absolute property of the company...' At the time of signing, some households were obviously more interested in getting the new energy source and were not aware of the implications of the contract. Other households were not even aware of the contractual obligation at the time they signed for the installation.[19] However, the only way that they could get out of the contract was for them to inform Eskom/Shell JV that they did not require their services; then the systems would be disconnected and taken away.

Non-grid households	*Signed a contract with company*	*Not signed a contract with company*
Fletcher	59%	41%
Bizana	100%	0%
Mt Ayliff	95%	5%
Flagstaff	86%	14%
Tabankulu	86%	14%
Matatiele	52%	48%

Table 5-2: Percentage of non-grid electrified households that were (were not) aware of signing contracts

Grid-electrified households did not sign such contracts. Instead, they just bought cards to recharge their supply. Although there are costs charged, such as meter and transmission costs, these are hidden in the overall electricity unit price except for VAT.

'We want cheaper electricity': payment options and households' perceptions

More than 90% of non-grid electrified households felt that the use of solar for lighting and entertainment appliances only was expensive compared to the price paid for grid

[18] The contracts were treated as the same documents as the application forms that households for the SHSs. Households were not given copies of contracts that they had signed for their own reference on these agreements.

electricity for the same services (Table 5.3). Dissatisfaction with the payment of the flat rate of R52 was exacerbated by the limited power that the system offered. It is worth noting that about 75% of non-electrified households thought that solar energy cards were expensive although they had never used solar electricity before many did not know what the service fee was for, they had learnt this from the non-grid electrified households.

Elec. Status	*Cheap*	*Reasonable*	*Expensive*
Non-grid	2%	7%	91%
Grid	16%	59%	25%
Non-electrified (only asked about non-grid electricity token costs)	0%	25%	75%

Table 5-3: Percentage of households that expressed their views on non-grid electricity card costs and grid electricity unit costs

Grid-electrified households were far more likely to state that electricity was affordable. Seventy-five percent of these households found no problems with the price of electricity, with about 59% stating that the price was 'reasonable'. This shows that the different services provided did not yield equal results from households.

A few non-grid electrified households indicated that they would prefer more options in terms of how frequently they pay for their monthly service fee. The majority of households (87%) said that the cards should be made affordable (cost less). The R52 they were paying per month was expensive compared to the grid-electrified households. It appeared that most did not have problems in terms of paying every month, as very few households preferred to pay weekly or bi-monthly (Table 5.4).

	Make affordable	*Pay weekly*	*Partly pay*	*Pay 2 months*
Mt. Fletcher	84%	0%	6%	9%
Bizana	98%	2%	0%	0%
Mt. Ayliff	98%	0%	0%	2%
Flagstaff	88%	8%	2%	2%
Tabankulu	91%	0%	0%	9%
Matatiele	63%	3%	0%	33%
All	87%	2%	1%	9%

Table 5-4: Percentage of non-grid electrified households that expressed their views on preferred payment options for their electricity supply

[19] According to Eskom/Shell JV, the company has a responsibility of ensuring that the households understand the terms of the contract (Horlock 2001: personal communication).

It appears that these rural non-grid electrified households were not given much choice as to the best affordable payment option. They were supplied with SHSs in the hope that they would be satisfied regardless of the cost and the manner in which the household had to pay. Households do not live in total isolation. They were aware that households with access to grid electricity paid far less for electricity use for televisions, radios and lights, than the R52 they were required to pay. They also knew that with grid electricity one could cook and refrigerate food.

	Outlet too far	*Outlet has no tokens*	*No maintenance by the service provider*
Mt. Ayliff	100%	0%	0%
Flagstaff	0%	0%	100%
Tabankulu	33%	67%	0%
Matatiele	100%	0%	0%
All	75%	20%	5%

Table 5-5: Percentage of households with access problems when buying non-grid cards

Although the 'outlets' for card purchases for solar electrified households were located within the villages in already existing shops or cafés, some of them were too far for people to walk. More than 70% of the households considered that the outlets were too far for them to walk to. 20% found that when they got there, cards were not be available (Table 5-5).

	Local non-grid outlet	*RESCO*	*Headquarters*	*Grid vendor*
Mt. Fletcher	97%	3%	0%	0%
Bizana	100%	0%	0%	0%
Mt. Ayliff	54%	44%	3%	0%
Flagstaff	96%	2%	2%	0%
Tabankulu	71%	21%	4%	4%
Matatiele	100%	0%	0%	0%
All	87%	11%	1%	0%

Table 5-6: Percentage of household's preference of outlets to purchase non-grid cards

About 87% of non-grid electrified households preferred to purchase cards at local outlets situated in the villages (Table 5-6). Only those that worked in towns or did shopping there bought cards at the RESCO offices or at the headquarters of the Eskom/Shell JV. Some householders preferred to purchase cards in town, as there were fewer problems than cards purchased in the villages. Households complained that some cards sold in villages 'did not last 30 days', or 'had no credits at all' forcing these households to go back to the outlets to get new cards.

	<2 km	*2-5 km*	*5-10 km*	*>10 km*
Mt Fletcher	97%	0%	3%	0%
Bizana	71%	29%	0%	0%
Mt Ayliff	52%	11%	36%	0%
Flagstaff	68%	28%	4%	0%
Tabankulu	35%	26%	35%	4%
Matatiele	100%	0%	0%	0%
All	70%	17%	12%	0%

Table 5-7: Percentage of non-grid electrified households & distances travelled to the nearest outlet

While it appeared that non-grid electricity card retailers were situated within reach, about 12% of households walk 5-10 km to purchase their cards (Table 5-7). It is must be noted that some outlets within walking distance would be closed or sometimes cease operation as they are unable to recover the money for cards given to customers that had taken them on credit.

As much as 24% of grid-electrified households found the electricity vendors situated far from households (i.e. 5 and 10 km away), and 49% of the households said the vendors were more than 10 km away from where they lived.

About 56% of non-grid and 88% of grid-electrified households had problems with their electricity supply (Table 5-8). Almost 70% of non-grid electrified households were not able to identify the problems with their systems but knew that in such instances they should report the problems to the service provider.

Elec. status	*Problem*	*No problem*
Non-grid	56%	44%
Grid	88%	12%

Table 5-8: Percentage of electrified households having problems with their electricity supply.

Non-grid electricity customers usually reported the problems with their systems to their outlets or RESCO offices. The technicians hired by Eskom/Shell JV attended to these problems at no charge unless the customer had deliberately interfered with the system.

Elec. Status	*Bad card*	*Low voltage*	*Fast card*	*Bad lights*	*No inspector*	*Unstable*
Non-grid	44%	23%	10%	22%	1%	0%
Grid	17%	9%	0%	0%	0%	74%

Table 5-9: Percentage of electrified households having different types of problems with their electricity service

However, most non-grid households mentioned a number of problems relating to their electricity supplies (see Table 5-9). These included newly bought cards not working and the systems' low voltage. Sometimes the cards did not have enough credits to last the 30 days. This in the end may have bad implications for the service providers as customers will not have much confidence in the service provided. The main criticism by grid-electrified households was that their electricity supply was 'not stable' (they were referring to fluctuating power output and frequent power supply blackouts).

5.5 Future customers: what service delivery will they opt for?

From the above discussion it is obvious that non-grid electrified customers do not have a choice in terms of the service provided for them. Grid-electrified households have a choice of the level of supply they want (20A or 60A) depending on whether they have enough money to pay for it. They also have a choice in the amount of electricity purchased because pre-payment meters allow them to use the amount of electricity they can afford at the time.

The households who are without electricity at all relied on the hearsay and experiences reported by people in grid and non-grid electrified households. It is probable that these households will not be connected to the national electricity grid soon, as most are situated in the remotest areas and are very far from the national grid. For these households, electrification means being connected to the national electricity grid. It was not made clear by the government that 'electricity for all' does not mean that everybody would be connected to the national electricity grid but other electricity supply options may have to be considered. The only realistic option is for them to receive non-grid electricity (in this case solar systems), or they would stay without electricity for the next 5-10 years, if not more, depending on Eskom extending the grid to these areas. Will the non-electrified households wait such a long time to have electrical lights in their households? Will these households settle for the non-grid electricity option that will only provide them with just enough power for lights and media?

5.6 Conclusion

Electricity (grid or non-grid) on its own cannot be said to be a sufficient tool to alleviate poverty as it is unfortunately frequently assumed. It is good to provide households with electricity, but on the condition that electricity does not exacerbate poverty. This chapter has illustrated the difficulties the sampled rural households encounter due to development interventions (which are implemented with good intentions) of providing non-grid electricity meant to alleviate poverty. Additional problems may in fact be created. Solar systems are best at providing lights and electrical power for media appliances, benefiting people who have never had access to electricity and live far from the national electricity grid lines. Households without doubt appreciate this supply. Electric lights certainly contribute to the improvement in peoples lives. The major problem with this type of supply is that it is too costly and targets only households that can afford the service fees. This well intended intervention also creates a problem in that it worsens social stratification in these rural areas – between the haves and the have-nots.

What does this mean for the community at large? As socio-economic divisions are recreated as a direct consequence of a development strategy, the sense of community is unfortunately weakened. The implications of development strategies on community relations are rarely considered before they are implemented. This chapter has attempted to show that a needs-based (rather than a electricity supply-based) development is better suited to addressing the needs of the rural poor.

CHAPTER 6:
Policy Implications and Conclusions

6.1 Introduction

Rural electrification in South Africa is perceived as an integral part of infrastructure development which links to alleviation of energy poverty and enhancement of rural development (Mlambo-Ngcuka 2002). The South African government has implemented the non-grid electrification programme in rural areas in order that all households have universal access to electrification so as to achieve a developmental goal. Despite the ambitious electrification programme, which began in the early 1990s, a significant number of rural households will not have access to electricity, at least in the short-to-medium term. The cost of extending the electricity grid to some rural localities is prohibitive and economically unsustainable. And yet, the South African government policy is to provide every household with electricity in a cost-effective and sustainable manner. The non-grid solar concessionaire programme, and of which the Eskom/Shell JV is part, provides electricity services to households that would not normally have access to grid electricity.

This thesis has documented the experiences of households that have access to the grid and non-grid electricity, as well as the non-electrified households. This comparison of the experiences reveals many important issues, which have theoretical, practical, and policy dimensions. The most important lesson is that fuel use patterns of households cannot be isolated from the social and economic contexts that shape them.

Energy use in these rural areas is compounded by poverty. It is important to note that *poverty* is the main determinant of livelihoods. The various patterns of fuel use reflect the households' response to the spectre of poverty. Any solutions must primarily address poverty or at least, ensure that these solutions contribute directly to poverty alleviation. The aim of introducing electricity to rural households should be primarily to reduce expenditures on fuels, not an additional burden on already overstretched household budgets. Some of the key issues raised in this thesis have important implications for policy. These issues are:

- Economical, social or cultural contexts shape energy use
- Analysis of energy end-use has a practical relevance in informing policy and strategies of intervention
- Supply-based and technology-driven solutions are unlikely to bring sustainable development to rural areas.

6.2 More than energy issues

The sampled households had different socio-economic backgrounds. Although most of these households were impoverished and located in one of the least developed provinces in South Africa, the degree of poverty was not the same. The location of these households was an influence of the types of energy sources these households were using. The poorest households were those who could not get grid electricity because they were located far from the grid network lines. Some households could afford to have SHSs installed in their homes but this did not change the fact that they still had to ensure that they had energy for thermal purposes. The location of the households also meant that they were far removed from the urban centres that could allow them better employment chances. Households without income had to use energy sources such as wood, candles and paraffin. This is important for policy in that strategies should be well targeted and flexible enough to understand that the rural poor are far from a homogenous mass.

Gender, for instance, still plays a pivotal role in the use of household energy resources. It has been demonstrated in this thesis that energy poverty has a woman's face: the very poor households, which lack access to appropriate energy, are likely to be headed by women (see Chapter 3: Figures 3-1 & 3-5). Men are likely to earn more than women and have a chance to be employed in a sector that employs men. Again, women-headed households are more likely to be using unhealthy energy sources (because these are affordable, according to the households' income), much to the detriment of their health and that of their households.

Education was one of the most important indicators of household energy use. Having better education made households aware of energy issues and general developments, issues around electricity supply and available options. The poor and uneducated are likely to have less access to new electricity supply options.

6.3 Energy demand in rural households

The methodological approach employed in this thesis is one that emphasises the end use rather than focusing on the fuel sub-sectors. It has both theoretical and practical importance. The key importance of end-use analysis is its strength in identifying the real *needs* of the poor households. It also follows that the majority of poor households have acute energy needs, but the *demand* for energy is low because these households could not afford to use new and costly energy technologies, such as solar PVs. Household energy use is more complex than the supply meeting the demand. Therefore, strategies should focus on transforming the energy needs into demand. Such strategies require an integrated approach to poverty, because the inability to use new sources of energy could be tied to rural underdevelopment.

The key research questions for this work were explored in Chapter one (Section 1.3). In conclusion it is important to assess the extent to which these questions were addressed. The assessment is as follows:

- To what extent does a household's geographical location influence its use of energy? - The study shows that location of the areas that were visited had an influence in the types of energy used by these households. Non-grid electrified households were provided with this electricity option because of their distances from the main electricity grid network. This means that it would have been more 'expensive' to provide them with grid electricity. Due to location in Bizana and Matatiele where there was good transport infrastructure, a significant number of non-grid electrified households (55% & 47% respectively) used gas for cooking (see Chapter 4, Figure 4-1). All the households interviewed used paraffin and wood (although non-electrified households depended more on these fuels) as cooking fuels because they could afford them more than electricity. Households also had easy access to paraffin as it was sold at the local shops and wood collected form nearby plantations.

- Does poverty contribute to lack of appropriate energy use, or does the lack of such energy service exacerbate poverty? - Poverty contributes to lack of appropriate energy use. Lack of employment in the researched rural areas means that people do not have money to pay for the electricity services provided because they are unaffordable. For instance, the non-electrified households surveyed could not afford to have electricity in their homes because of their low incomes (see Chapter 3, Figure 3-6). Furthermore, most of these impoverished households were female-headed (Figure 3-5) putting them at a further disadvantage of walking long distances to collect firewood.

- Why is it that households find it difficult to switch completely to 'modern' energy sources for thermal applications, yet find it easier to do so for media appliances? - This thesis has also shown that the use of media appliances with grid and non-grid electricity is more than the use of other household appliances. It does seem like these households are able to make a transition from use of dry cell and car batteries, petrol or diesel generators for their radios and television but find it difficult to make this transition when it comes to energy for thermal applications. The main reason for this may be that media appliances are commonly used and more affordable than thermal appliances regardless of the electrification status of the household. Conversion of these appliances from use of conventional fuels to use of electricity is cheaper than investing in new appliances for cooking, space heating & cooling and refrigeration.

- How can we turn the energy needs of households into effective demand of energy? - Energy needs of households should be turned into demand by providing sources that will be affordable for these households and at the same time alleviate poverty. The research has shown that energy provision does not have to be of one particular electrification option but a sustainable combination of energy sources as it has been shown that there are high levels of multiple fuel-uses in the areas visited.

- More specifically, how should policy makers approach energy poverty in rural areas? - The research has also shown that energy poverty is not the only problem that affects these rural areas but other services need to be provided as well in an integrated way. There is a need to alleviate the levels of education in the rural areas. With higher levels of education, people will be employed and thus have the ability to afford and make appropriate choices regarding the electrification options they are provided with.

- What must be done or not done in the implementation of sustainable energy options? - There is a need for policy makers and implementers to practice participatory methods of delivery of services to rural areas. This will ensure that people's needs are addressed to avoid duplication or under servicing of these rural areas.

6.4 Considerations for future electrification policies

People should be active participants in their own development. Thus, electricity supply options should address the *real* needs of households. To this end, energy users should be consulted about the delivery modes of electricity introduced in their areas. The provision of solar energy is a good initiative considering that most of these people did not have such services as electric lighting before. Although the provision of solar energy is highly subsidised, it does not simply mean that people will accept it because they still have to pay for the services. The R52 per month that households were required to pay is too expensive for an energy service that would only provide power for a few hours and limited number of end uses. Moreover, solar PVs favour the 'rich' in poor areas, thereby reinforcing class divisions in rural areas. This discriminatory approach to development could destroy the moral fabric of rural society, as it pushes the very poor and women deeper into the abyss of poverty and further marginalise them from their own community.

Implications of study for future rural energisation

As this thesis has explored the needs-based impact assessment of grid and non-grid households' electrification in the Eastern Cape rural communities of South Africa, there is a need to further explore the study's implications for future rural energisation. The issues are as follows:

- Need to address the lack of basic energy services in the rural areas - The study has shown that electrification on its own does not solve poverty problems in the rural areas. There is a need to integrate energy services in the rural areas with broader development initiatives such as improving road infrastructure, health facilities, education, telecommunications and safety issues. Improvement of road infrastructure could facilitate in better delivery of energy services and other basic services such as health.

- Lack of employment opportunities - The rural areas of the Eastern Cape have high numbers of unemployed people, as these opportunities are rare in the province. In order for people to benefit from a development initiative such as installation of electricity (grid or non-grid), other socio-economic problems will have to be addressed such as employment opportunities that can be created through electrification for people. These opportunities should be initiated through the electricity service delivery by building capacity amongst the rural communities with regard to small business development focusing on businesses that use electricity whether grid or non-grid.

- Heterogeneity of households' socio-economic situations – This should be considered when implementing electrification programmes in the rural areas. This thesis has shown that rural households are not homogeneous in terms of their economic and social backgrounds. The electrification programmes such as non-grid electrification do not suite everyone's needs and cannot be afforded by all the households. There are households that do not benefit from the electrification process that is taking place because they are poor.

- Solar energy promotes multiple fuel use - The SHSs were installed in these rural areas so as to improve people's livelihoods. However, as shown in Chapter 4, many of these rural households researched are still using less convenient fuels such as paraffin and wood for thermal applications since the non-grid electricity that has been provided to them does not satisfy their thermal energy needs. This point does not refer to non-grid electricity only as it has also been shown in Chapter 4 that households with this grid electricity do not utilise it fully especially for thermal purposes because of reasons such as costs of this supply and the cost of electrical appliances. This clearly shows that with the provision of electricity options, thermal needs in the rural areas remain the most important end-use. The electrification process in these rural areas should be accompanied by delivery of other energy services such as access to fuels like paraffin and gas. If these fuels are readily accessible in these areas, the costs for rural households could be decreased, as they would not have to travel far to access them.

- Gender and energy – Chapter 3 of this thesis has shown that not only do the non-electrified households have low incomes but also most of them are female-headed (see Figure 3-1). Provision of non-grid electricity in the rural areas should ensure that these households can afford such services or provide other alternatives in terms of energy sources so that these households can meet their energy needs. Even the non-grid electrified households are placed at a disadvantage as they still have to ensure that they have sufficient energy sources for their thermal needs meaning that women are still faced with collecting wood for cooking, water heating and space heating.

Research needs flowing from this work

This study shows that there is an importance of needs-based end-use analysis before the implementation of any electrification option especially in the rural areas. Before any development projects are carried out it is important to identify what the needs of such areas are and whether there is a demand for the service provided. The research needs flowing from this thesis are as follows:

1. Grid-electrified households paid less for a high level service. Is non-grid electricity (SHSs) worth the investment? – There is a need to research the issue of payment for the non-grid electricity service. Grid-electrified households pay an average of R30 per month (Chapter 4, Table 4-1) for electricity, although not all of them use their electricity supply to the optimum because of costs, they can meet almost all of their energy needs. On the other hand, non-grid electrified households have a limited supply of electricity that can only be used for lights and media appliances whereas they have to pay a fee of R52 per month regardless of whether they are using the electricity supply or not.

2. Is the risk of theft worth the risk of technical failure? – Non-grid electricity service providers had to put anti-theft mechanism in place to ensure that the panels are not stolen from households. This mechanism caused problems with the electricity supply and households were left without electricity for long periods. The service providers were then faced with the costs of rectifying the problems caused by the anti-theft mechanisms. The service providers could have explored the possibilities of involving the communities in monitoring the theft problems in the areas so that households could have the sense of ownership of this electrification programme. Research needs to be done to explore the possibilities of community involvement in such programmes so as to lower the costs of electrification and ensuring the ownership of such development programmes by the communities.

3. What level of implementation is required to test the SHSs programme? – When the non-grid electrification programme first started in the research areas, implementation was carried out at a large scale whereby thousands of SHSs were installed (6000 SHSs were installed between 1999 and 2001). This was done without testing whether the programme will be effective or not and how the households would respond to it. National programmes such as the non-grid electrification programme need to be implemented on a small scale first to test whether they can be effective and check the acceptability by the households that use the SHSs.

4. In such a difficult terrain, is solar electrification a high priority? – The Eastern Cape province, especially the research areas, is located in difficult terrain in terms of roads. The is a need to analyse what the priority needs of such an area are through consultation with the communities and if funds are to be allocated, that should be done for the priority needs first. Although electrification is a basic need for all households, there is a need to explore what the other needs are and whether electrification (especially non-grid) is a priority instead of provision of other energy sources.

5. How best to deliver thermal energy in the energisation programme? – Although non-grid electricity provides lights and the ability to use media appliances it still leaves out the most important energy need for the rural households. Thermal energy is important, as households need it to cook, water heating and space heating. Not all of these households energy needs are fully met by providing them with non-grid electricity instead they are still faced with finding ways to meet their thermal energy needs. There should be other energy services provided together with the delivery of SHSs to households so that they can meet their thermal energy needs.

6. Is solar electricity in remote areas more economical than grid electricity when sustainable development is considered? – Delivery of grid electricity is said to be costly because of the large distances from the national grid (Mlambo-Ngcuka 2002). The research areas were provided with non-grid electricity due to this belief. It was not considered that providing these rural areas with grid electricity might bring employment opportunities and contribute towards the energisation of these areas.

Electrification may trigger investments by big businesses and small business development in the rural areas, which in turn will bring economic development.

6.5 Conclusion

It needs to be underscored that poverty is omnipresent in rural areas. What would be the best approach to address poverty? Would the introductions of new forms of energy solve the poverty problems? On the other hand, would the introduction of electricity bring about development in rural areas? The answer to these questions is double-edged. Energy is a key component of rural development, yet energy demand in rural areas is very low due to their underdeveloped nature. Even if one brings modern energy technologies to the most rural poor, there would be cost-linked problems relating to their use.

This thesis has also shown that the use of media appliances with grid and non-grid electricity is more than the use of other household appliances in the surveyed areas. It does seem like these households are able to make a transition from use of car batteries and petrol or diesel generators for their radios and television but find it difficult to make this transition when it comes to energy for thermal applications. The main reason for this may be that these households had invested in these appliances long before they were provided with grid and non-grid electricity. Moreover, conversion of these appliances to use electricity is cheaper than investing in new appliances.

Should one, then, introduce development before introducing new forms of electrification options? The answer to this development problem, as the thesis has mentioned repeatedly, lies in the analysis of the real energy needs of the households through exploring the end-uses. Integrated rural development, which appreciates the complementarities of rural needs, is the simple answer to addressing rural poverty. Many researchers have made this point, but to carry it out has been a different proposition.

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Appendix A: Questionnaire used for all SHS users' survey

First monitoring study - Eskom-Shell JV project in Eastern Cape

Solar Home System users

General

Name of Interviewer	[]
Date	[]
District []	
RESCO location	
Community name	[]
Questionnaire number	[]

Household, Respondent, Household Head, Household members

What is your (the respondent's) name?	
What is the surname of the household?	
What is the full physical or PO Box address of the household?	
What language do you mostly speak at home?	Xhosa [1] Zulu [2] Other (specify)........................[ ]
FILL THE INFORMATION ABOUT THE HOUSEHOLD MEMBERS IN TABLE 1 BELOW	

Homestead

What type of homestead/dwelling do you have? (MARK MORE THAN ONE IF NECESSARY)	Traditional homestead [1] Single house with multiple rooms [2] Mixture of traditional huts and other buildings [4] Informal house (shack) [8] Other (specify)........................[ ]
How many buildings form part of the homestead?	]
How many rooms do you have altogether?	]
Is there a ceiling in the house, or in some rooms of the homestead?	Ceiling in all rooms [1] Ceiling in some rooms [2] No ceiling [3]
Are you building a house or extending the house at the moment?	Yes [1] No [2]

Application for, installation and ownership of Solar Home System

How many Solar Systems do you have?	[]
When was the Solar System(s) installed in your home (month and year)?	[]
Who in the household made the decision to apply for the Solar System?	[]
How did you find out about the Solar System?	[]
Why did you decide to get a Solar System?	[]
IF THEY HAVE MORE THAN ONE SOLAR SYSTEM, Why did you get more than one?	[]
Where did you apply for the Solar System?	

If they applied at an outlet – give the location of the outlet.	[]
How much did you pay to apply for the Solar System?	[]
How long did it take before the Solar System was installed?	[]
Who installed the Solar System at your home (name and business, if possible)?	[]
Do you have any complaints about the installation of the Solar System?	Yes [1] No [2]
IF THEY HAVE COMPLAINTS, what are these?	[]
Where is the Solar panel installed?	In a shade (1) On a pole [2] Other (specify)..[]
Did the household decide where the Solar system unit (with battery, meter and plugs) should be placed inside the house?	Yes [1] No [2]
In which room is the Solar system unit with the battery, meter and plugs installed?	Lounge [1] Kitchen [2] Bedroom [4] Room at the back of the shop [ ] Other (specify)..[]
IF THE HOUSEHOLD MADE THIS DECISION, Why did you choose this particular room?	[]
Are you satisfied or dissatisfied with the location of the Solar System unit inside the house?	Dissatisfied [1] Satisfied [2]
IF THEY ARE DISSATISFIED, What are the reasons?	[]
Did the technician explain to you the following: How the Solar System works?	Yes [1] No [2]
How you should use the Solar System?	Yes [1] No [2]
How to take care of the Solar System?	Yes [1] No [2]
How to connect appliances to the Solar System?	Yes [1] No [2]
Do you know which appliances can be connected to the Solar System?	Yes [1] No [2]
Are you responsible for maintaining the water level in the battery?	Yes [1] No [2
Are you responsible for cleaning the panel?	Yes [1] No [2]
Who is the household was given information about the Solar System?	Use person code in Table1
Did you receive any written information about the Solar System?	Nothing [1] User's manual [2] Pamphlet [4] Poster [8] Other (specify).. []
In what language was the written information on solar systems?	Xhosa [1] Zulu [2] English [4] SeSotho [8]
Who has read the information for the household?	Installer [1] Household member (use code on Table1) [ ] Inspector [4]

	Area manager [8] Outlet [8] Nobody [8]
Has the information helped the household?	Very useful [1] Not at all [2] Other (specify)..........................[]
Did you sign a contract with Eskom-Shell before the Solar System was installed?	Yes [1] No [2]
Did someone explain the contract to you before you signed?	Yes [1] No [2]
Do you understand the terms of the contract?	Yes [1] No [2]
IF SOMEONE EXPLAINED THE CONTRACT TO YOU, Who did this?	[]
Are you satisfied or dissatisfied with the contract?	Satisfied [1] Dissatisfied [2]
IF THEY ARE DISSATISFIED, What are the reasons?	[]
Who owns the Solar System? (DO NOT PROMPT)	They (the household) own the system [1] Eskom-Shell owns the system [2] Government owns the system [4] Don't know [8] Other (specify)..........................[]
Who has to repair the Solar System if it is broken? (DO NOT PROMPT)	They (the household) [1] Eskom-Shell [2] Don't know [4] Other (specify)..........................[]

Service payment for Solar Home System, and vending station

How much do you pay for the prepayment token for the Solar System?	[]
What do you think of the cost of the prepayment token?	Cheap [1] Reasonable [2] Expensive [3] Other (specify)..........................[]
How much do you think you should pay?	
Who in the household pays for the prepayment token most of the time?	
Where does this person live?	[]
Does he/she earn a regular income?	[]
How often do you generally buy the prepayment token for the Solar System?	Every month [2] Every second month [1] Other (specify)..........................[]
IF THEY DON'T BUY IT EVERY MONTH, how often are they able to buy it in a year? What is the reason for this?	
When do you buy the prepayment token for the Solar System?	Before the new month starts [1] On the first day of the month [2] In the first week of the month [4] Pension pay-out day[ ] Other (specify)..........................[]
IF THEY BUY IT AFTER THE FIRST DAY OF THE MONTH, what is the reason for this?	

	[]
Do you have any suggestions to make payment easier for people? (DO NOT PROMPT)	Make token cheaper [1] Pay weekly rather than monthly [2] Pay for only part of the month [4] Pay every two months [ ] Other (specify)..........[]
How long do you expect to be paying for the use of the Solar System? (DO NOT PROMPT)	For as long as they have the Solar System [1] Until they get grid electricity [2] Until they own the system [4] Other (specify)..........[]
Where do you buy the prepayment token for the Solar System?	[]
Do you feel satisfied or dissatisfied with the outlet where you buy the prepayment token?	Satisfied [1] Dissatisfied [2]
IF DISSATISFIED, what is the reason for this?	[]
How far is the outlet where you buy the prepayment token?	Less than 2 km [ ] Less than 5 km [1] Between 5 km and 10 km [2] More than 10 km [4]
Has the outlet ever been closed when you wanted to buy a token?	Never [1] Sometimes [2] Often [4]

Use of Solar lights inside the house

How many lights inside the house are connected to the Solar System?	[]
How many bedrooms in the house have lights that are connected to the Solar System?	[]
IF THERE ARE BEDROOMS WITH SOLAR LIGHTS, Who sleep in these bedrooms?	Household head [1] Other adults in household [2] School going children [4] Other (specify names)..........[]
Whose decision was it to install the lights in the rooms where they are?	Member of the household [1] The technician who installed it [2] Other (specify)..........[]
Are you satisfied with the location of the lights?	Yes [1] / No [2]
IF THEY ARE NOT SATISFIED, What are the reasons?	
How many of the inside lights do you use almost every day?	]
How many of the Solar lights inside your house are broken (if any)?	]
How long have they been broken?	

FILL IN TABLE 4 BELOW by asking the questions. EXPLAIN that you want to know about rooms where they use the Solar lights in the late afternoon or evening, but they have to use the lights for more than just a few minutes at a time

Table 4: Use of Solar lights in the late afternoon and evening for summer and winter seasons

	In which rooms do you regularly use the Solar lights in the late afternoon or evening?	At what time do you generally switch on the Solar light in the room?	At what time do you generally switch off the Solar light in the room?
Summer	Examples: Lounge – L, Kitchen – K	7 pm	10 pm
	Bedroom 1 – B1, Bedroom 2 – B2	10 pm	about 10:15 pm
Winter			

Do you do any of these activities while the Solar lights are switched on? (CHECK EACH OPTION WITH THEM)	Socialise/rest [1] Watch TV/listen to radio [2] Read/write [4] Do school homework/study [8] Do household chores (cooking, cleaning etc) [16] Make handcrafts/do sewing etc [32] Bath/prepare for work (in the morning) [64]
Do they ever switch off the solar light while they are watching television at night?	Yes [1] / No [2]
IF THEY DO, why?	
Do you usually switch off the Solar light if nobody is using a room, or do you leave it on?	Switch it off [1] Leave it on [2]
What are the reasons why you do this?	
Are the solar lights brighter (b), darker (d) or the same(s) as the	candles [ ] paraffin [ ] Gas [ ] Grid electricity lights [ ] Other [ ]

Do you generally use the Solar lights in the mornings?	Yes [1] No [2]
IF THEY USE SOLAR LIGHTS IN THE MORNINGS, Ask the following questions:	

Questions:	Summer:	Winter:
How many Solar lights do you generally use in the mornings?		
At what time do you generally switch on the Solar lights in the morning?		
At what time do you generally switch off the Solar lights in the mornings?		
What do you use the Solar lights in the mornings for?		

Use of Solar lights outside the house

Do you have any Solar lights outside the house?	Yes [1] / No [2]
IF THEY HAVE OUTSIDE LIGHTS, Ask the following questions:	
How many lights outside the house are connected to the Solar System?	[]
How many outside lights do you switch on in the evening?	]
At what time do you switch on the outside lights in the evening?	]
At what time do you switch off the outside lights in the evening?	]
Have the outside lights had an impact on the security of your home?	Yes [1] No [2]
Do you generally leave any outside lights on during the night?	Yes [1] No [2]

IF THEY LEAVE LIGHTS ON DURING THE NIGHT, Ask the following questions:	
How many lights do you leave on at night?	]
At what time do you switch off these lights in the morning?	]

Appliances operated with the Solar System

FILL IN TABLE 2 ABOUT THE SOLAR APPLIANCES OWNED BY THE HOUSEHOLD

Use of Solar TV

Do you operate a TV with the solar system?	Yes [1] No [2]
How many days per week do you generally watch TV using the Solar System?	Every day [7] About three days per week [3] One day per week [1] Other (specify)........................[ ] Less often than one day per week [99] Never [101]
For how many hours do you generally watch TV on one day using the Solar System?	About four hours [4] One hour [1] Other (specify)........................[ ] Less than one hour [99]
Do you use the Solar TV in the way you have described in winter and in summer, or do you use it less at certain times of the year?	Use less in winter [2] Use more in winter [ ] Same [ ] Other (specify)........................[ ]
Who watches TV most of the time?	Adult men [1] Adult women [2] School-going children [4] Other (specify)........................[]
Do you watch the news and other programmes that give you information about the world?	Every day [3] Sometimes [2] Never [1]

Use of Solar radio

Do you operate a Radio/Hi-Fi/Cassette player with the solar system?	Yes [1] No [2]
How many days per week do you generally listen to the radio/hi-fi/cassette player, using the Solar System?	Every day [7] About three days per week [3] One day per week [1] Other (specify)........................[ ] Less often than one day per week [99] Never [101]
For how many hours do you generally listen to the radio/hi-fi/cassette player on one day, using the Solar System?	About eight hours [8] Four hours [4] One hour [1] Other (specify)........................[ ] Less than one hour [99]

Do you use the Solar radio/hi-fi/cassette player in the way you have described in winter and in summer, or do you use it less at certain times of the year?	Use to the same extent throughout the year [1] Use less in winter [2] Use more in winter [ ] Other (specify)..[ ]
Who listens to the Solar radio/hi-fi/cassette player most of the time?	Adult men [1] Adult women [2] School-going children [4] Other (specify).. []
Do you listen to the news and other programs on the radio that give you information about the world?	Every day [3] Sometimes [2] Never [1]

Use of Solar System

What other appliances do you operate with the solar system except for the TV, radio/Hi-Fi/cassette player?	
Which of these appliances do you use once per week?	
Do you know how many hours you can use the solar system for per day?	
How do you feel about the number of hours for which you can use the Solar System every day?	It is enough [1] It is too short [2] Other (specify)..[]
If you had a larger Solar system, what would you use it for?	Use inside lights more [1] Use outside lights more [2] Watch videos [ ] Watch TV more [4] Use coloured TV [ ] Other (specify)..[]
Would you be willing to pay more every month for a larger Solar System?	Yes [1] No [2]
Do you know how to check how much power is available in the battery of the Solar System?	Yes [1] No [2]
If NO, WHY NOT?	Complicated [2] Unreliable [ ] Other [4]
Do you generally use the Solar system until the power cuts out?	Yes [1] No [2]
IF THEY DO, At what time does the power cut out on most days?	[]
IF THEY DON'T, When do you usually stop using the Solar system at night?	[]
Do you use the solar system for the same length of time in summer and in winter?	Yes [1] / No [2]
If no, what are the reasons?	
How many hours do you use it for? In summer.............................. In winter..................................	

Problems with Solar Home System, and light replacements

How often does an inspector comes to check the system?	Yes [1] No [2]
How many times has the solar system been checked?	[]
When was the last time the solar system was checked?	[]
Have you experienced any problems with the Solar System since you got it?	Yes [1] No [2]
IF THEY HAVE HAD **NO PROBLEMS** WITH THE SOLAR SYSTEM, Ask the following questions:	
Do you know what to do when you have a problem?	
Where would you report the problem?	[]
IF THEY HAVE **HAD PROBLEMS** WITH THE SOLAR SYSTEM, Ask the following questions:	
Are you able to identify the source of the problem on the system?	
How many times have you had problems since you had the solar system?	[]
Describe the problems	card not working at all [1] Low voltage [4] Card not lasting the full month [8] Lights not functioning [8] Inspectors not attending to the problems [ ] Other [ ]
Did you report the problems?	Yes [1] No [2]
Where did you report the problems?	Eskom/Shell office (Port Shepstone) [1] Inspector [4] Area manager [8] Outlet [8] Other [8]
Have any of the problems been solved?	Yes [1] No [2]
Are any of the problems still not solved?	Yes [1] No [2]
IF SOME OF THE PROBLEMS WERE SOLVED, Ask the following questions:	
How long did it take before it was solved?	[]
Who came to fix the Solar System?	Inspector [4] Area manager [8] Other [8]
Are you satisfied or dissatisfied with the service you got from the technician?	Satisfied [1] Dissatisfied [2]
IF THEY ARE **DISSATISFIED**, What are the reasons?	[]
Did you have to pay the technician who fixed the Solar System?	Yes [1] No [2]
If yes, how much did you have to pay?	
IF SOME OF THE PROBLEMS ARE STILL NOT SOLVED, Ask the following questions:	
Why was it not solved?	[]
Who is responsible for solving these problems?	[]
How do you feel about the problems not being solved?	

Have you ever stopped your monthly payments because the system was not working well?	Yes [1] No [2]
How long have you had to stop your monthly payments?	
Have you ever tried to fix any problems with the Solar system yourselves?	Yes [1] No [2]
Are you allowed to fix any problems with the solar system yourself?	
Have your Solar lights had to be replaced since you got the Solar System?	Yes [1] No [2]
IF THEIR SOLAR LIGHTS HAVE BEEN REPLACED, Ask the following questions:	
How many lights have been replaced?	[]
What type of lights have they been replaced with?	Special lights for Solar systems [1] Ordinary electric lights [2] Other (specify)..........[]
Who has replaced the solar lights for you?	Inspector [4] Area manager [8] Household member [8] Other [8

Ownership of other energy appliances

FILL IN THE TABLE BELOW BY ASKING WHAT APPLIANCES THEY HAVE WORKING ON DIFFERENT FUELS

Table 10: Other Household energy appliances

Questions		Which appliances? (circle)	How many?	Working (w) or broken (b)?
Do you have any paraffin appliances?	Yes [1] No [2]	Paraffin Wick Lamps		
		Paraffin Storm Lamps		
		Paraffin Flame Stove		
		Paraffin Primus Stove		
		Paraffin Heater		
		Paraffin Fridge		
		Other:		
Do you have any gas appliances?	Yes [1] No [2]	Gas Lamps		
		Gas Bottle with burner		
		Gas Stove without oven		
		Gas Stove with oven		
		Gas Fridge/Freezer		
		Other:		
Do you have appliances for burning coal?	Yes [1] No [2]	Coal stove		
		Coal Mbaola		
		Other:		
Do you make woodfires?	Yes [1] No [2]	Outside fireplace		
		Inside fireplace		
		Coal stove		
		Special wood stove		
		Other:		
Questions		Which appliances? (circle)	How many?	Working (w) or broken (b)?

Do you operate any appliance with a car battery? Yes [1] No [2]	Inside lights		
	Outside lights		
	TV (black & white / Coloured)		
	Other:		
Do you operate any appliances with dry-cell batteries? Yes [1] No [2]	Radio		
	Torch		
	Other:		
Do you operate any appliances with a petrol generator? Yes [1] No [2]	Inside lights		
	Outside lights		
	Other:		
Do you have any other electrical appliances that can't be used with the Solar system? Yes [1] No [2]	Kettle		
	Hot-plate/stove with oven		
	Iron		
	Fridge/freezer		
	TV (black & white / coloured)		
	Radio		
	Hi-fi		
	Video		
	Other:		

Table 11: End-uses of fuels. What is the main fuel that you use for the following end-uses. Please mark one fuel for each end-use with a tick and write beside it the number of the fuel you would like to switch to given the opportunity.

	Elec - 1	Gas - 2	Paraffin - 3	Wood - 4	Coal - 5	Candles - 6	Car battery 7	Dry cell batteries - 8	Petrol for generator - 9	Solar - 10
Lighting										
Cooking										
Water heating										
Space heating										
Space cooling										
TV										
Radio										
Geyser										
Fridge										
Ironing										
Other - specify										

Use of Candles

Do you use any candles? Yes [1] / No [2]

IF THEY USE CANDLES, Ask the following questions

How often do you generally buy candles?

Once a month [1]
Twice a month [2]
Once a week [3]
Every second day [4]
Every day [5]
Other (specify)...[ ]

How many candles do you generally buy at one time?

One candle [1]
A packet of six candles [6]
Other (specify)...[ ]

IF THEY BUY MORE CANDLES BEFORE THE END OF THE MONTH, Ask the following question:

How many extra candles do you buy to last the whole month? [ ]

How much do you pay for the candles you buy?	For one candle..........................[ ] For a packet of six........................[ ] Other (specify) ....[ ]
What are all the things you do with candles?	Lighting [1] Make polish [2] Other (specify) ....[ ]
How often do you use candles for lighting?	Every day [1] One or two days per week [2] More than two days per weak [ ] One or two days per month [3] Less often [4] Other (specify) ....[ ]
How many candles do you use at a time for lighting?	[]
How long in hours do you use the candles on one night?	[]
IF THEY USE CANDLES TO MAKE FLOOR POLISH, Ask the following question: How many candles do you use in one month for making floor polish?	[ ]

Paraffin

Do you use any paraffin?	Yes [1] / No [2]

IF THEY USE PARAFFIN, Ask the following questions:

How often do you generally buy paraffin?	Once a month [1] Once a week [2] Every day [3] Other (specify)...[]
How much paraffin do you generally buy at one time?	1 litre [1] 2 litres [2] 5 litres [5] 10 litres [10] 20 litres [20] Other (specify)...[]
How long does this paraffin last?	One month [] Two weeks [] One week [] Two days [] One day [] Other (specify)...[]

How much do you pay for the paraffin you buy?	For 1 litre........................ [] For 5 litres.........................[] For 10 litres ....[] For 20 litres........................ [] Other (specify)...[]
What are all the things you do with paraffin?	Make polish [1] Cooking [2] Ironing [4] Lighting [8] Heat water [16] Run a fridge/freezer [32] Other (specify)..[]
How often do you use paraffin as a fuel, (eg. for cooking, ironing, lighting, heating water, fridge)	Every day [1] One or two days per week [2] More than two days per week [ ] One or two days per month [3] Less often [4] Other (specify) ....[]
Where do you buy paraffin?	
How far is it in kilometres?	
How much does a return trip cost?	
IF THEY USE PARAFFIN TO MAKE FLOOR POLISH, Ask the following question: How much paraffin in litres do you use in one month for making floor polish?	

Gas

Do you use any gas?	Yes [1] / No [2]

IF THEY USE GAS, Ask the following questions:

Where do you buy gas?	
How much does a return trip cost?	
How long does a return trip take?	quarter of a day [1] half a day [2] whole day [ ] Other (specify)..[]
How often do you generally buy gas?	Once every two months [1] Once every three months [ ] Once a month [2] Once a year [ ] Twice a year [ ] Other (specify)..[]

How much gas do you generally buy at one time? (tick one or more) If cylinder is used more than once, indicate number next to type:	4.5 kg [] 9 kg [] 19 kg [] 48 kg [] Other (specify)...[]
How long does this gas last?	Two weeks [ ] One month [] Two months [] Three months [ ] Six months [ ] 1 year [ ] Other (specify)...[]
How much do you pay for the gas you buy at one time? For all cylinders	For 4.5 kg ....[] For 9 kg.........................[] For 19 kg.......................[] For 48 kg ....[] Other (specify)...[]
What are all the things you do with gas?	Cooking [1] Ironing [2] Heating water [4] Lighting [8] Run a fridge/freezer [16] Other (specify)...[]
How often do you use gas?	Every day [1] One or two days per week [2] More than twice per week [ ] One or two days per month [3] Less often [4] Other (specify) ....[]

Wood

Do you use any firewood?	Yes [1] / No [2]

IF THEY USE FIREWOOD, Ask the following questions:

Do you collect firewood or buy firewood or do both?	Collect firewood [1] Buy firewood [2] Collect and buy firewood [3]
IF THEY COLLECT FIREWOOD, Ask the following questions	
How long is the return trip to collect firewood in hours/km?	.....km/hours by car ....when walking ....Other

Where do you collect firewood?	On the hill [1] On the forest [2] On the farm [ ] Other (specify)..[]
How much firewood do you generally collect at one time?	One headload collected by one person [1] Two headloads collected by two people [2] Other (specify)..[]
What type of firewood do you collect?	Green [ ] Dead [ ]
Why?	
How often do you collect firewood?	everyday [ ] Once per week [ ]
How long does the firewood last?	One day [1] One week [2] Other (specify)..[]
IF THEY BUY FIREWOOD, Ask the following questions	
How much firewood do you generally buy at one time?	Bakkie load [1] Headload [ ] Wheelbarrow [ ] Other (specify)..[]
How much do you pay for this firewood?	For a bakkie load ....[] Wheelbarrow load..[] Other..
How long does this firewood last?	Two months [1] Month [2] Other (specify)..[]
What are all the things you do with firewood?	Cooking [1] Ironing [2] Lighting [4] Heat water [8] Warm themselves [16] Baking [32] Sitting and chatting [ ] Other (specify)..[]
How often do you use firewood?	Every day [1] One or two days per week [2] More than two days per week [ ] One or two days per month [3] Less often [4] Other (specify) ....[]

Coal

Do you use any coal?	Yes [1] / No [2]

IF THEY USE COAL, Ask the following questions:

Where do you buy coal?	
How much does the return trip cost?	
How much coal do you buy at one time?	[]
How much do you pay for this coal?	[]
How long does the coal last?	[]
What are all the things you do with coal?	Cooking [1] Ironing [2] Lighting [4] Heat water [8] Warm themselves [16] Baking [32] Other (specify)..........[]
How often do you use coal?	Every day [1] One or two days per week [2] One or two days per month [3] More than two days per month [4] Other (specify) ....[]

Drycell batteries

Do you use any drycell batteries (e.g. PM or PP)?	Yes [1] / No [2]

IF THEY USE DRYCELL BATTERIES, Ask the following questions:

What type of batteries do you buy?	PM9 [1] PM10 [2] PP9 [3] PP10 [4] R20PP [5] Other (specify)..........[]
How often do you buy batteries?	Once a week [4] Every second week [2] Once a month [1] Other (specify)..........[]
How many batteries do you buy at one time?	[]
How much do you pay for the batteries you buy?	For PM9..........[] For PM10..........[] For PP9..........[] For PP10..........[] For R20PP ....[]

How often do you use batteries?	Every day [1] One or two days per week [2] One or two days per month [3] More than two days per month [4] Other (specify) ....[]
How many hours do you use batteries a day?	
What do you use the batteries for?	Lighting (torch) [1] Radio [2] Hi-fi [3] Other .... [ ]

Car battery

Do you use a car battery?	Yes [1] / No [2]

IF THEY USE A CAR BATTERY, Ask the following questions:

What type of car battery do you use?	12V [1] 24V [2] Other (specify)..[]
How often do you charge the car battery?	Everyday [ ] Once in 3 days [ ] Once a week [4] Every second week [2] Once a month [1] Other (specify)..[]
Where do you charge your battery?	
How much do you pay for the return trip?	
How many batteries do you generally charge at one time?	[]
How much do you pay for charging one battery?	[]
How often do you use a car battery?	Every day [1] One or two days per week [2] More than two days per week [ ] One or two days per month [3] Other (specify) ....[]
How many hours do you use a car battery on one day?	

Generator

Do you use a generator?	Yes [1] / No [2]

IF THEY USE A GENERATOR, Ask the following questions:

How often do you buy fuel (petrol or diesel) for the generator?	Once a month [1] Every week [ ] Every second month [2] Other (specify)...[]
How much fuel (petrol or diesel) do you generally buy at one time?	....litres []
How much do you pay for the fuel (petrol or diesel)?	Per litre []
How often do you use the generator?	Every day [1] One or two days per week [2] More than two days per week [ ] One or two days per month [3] Other (specify) ....[]
How many hours do you use the generator on one day?	

Other fuels

Do you use any other fuels at this time of the year?	Yes [ ] / No [ ]
What are these fuels?	Cow dung [ ] Crop residues [ ] .... Other [ ]
How often do you use these fuels?	Every day [ ] Twice per week [ ] One month in a year [ ] Summer only [ ] Winter only [ ] ....Other [ ]

Changes in fuel use

Are there any fuels which you **use less** since you got the Solar System?	Yes [1] No [2]
IF THERE ARE FUELS THEY **USE LESS**, Which fuels are these? (DO NOT PROMPT)	Candles [1] Paraffin [2] Gas [4] Car battery [8] Generator [16] PM/PP batteries [32] Other (specify)...[]
Are you spending more money or less money on fuels since you got the Solar System?	More money [1] Less money [2] The same money [3] Don't know [4]

Why do you say this?	
IF THEY SPEND **LESS MONEY** NOW, how much money do you save in a month?	[]
IF THEY SPEND **MORE MONEY** NOW, Ask the following questions:	
How much more do you spend now in a month than before?	[]
Are there any things you cannot buy anymore because you have to pay for the Solar System?	Yes [1] No [2]
IF THERE ARE, What are the things you can no longer afford?	[]

Changes in study and reading patterns

Is there anyone in the household who studies or do homework?	Yes [1] No [2]
IF THERE IS SOMEONE WHO STUDIES OR DO HOMEWORK, Ask the following questions:	
How many members of the household studies or do homework?	[]
How often do they study or do homework? (ONE OPTION ONLY)	Every day [7] About three days a week [3] One day a week [1] Other (specify)...[]
At what time of day do they study or do homework?	Early morning [1] During the day [2] In the evening [4] At night [8]
How long do they study or do homework on one day?	Less than one hour [1] A few hours [2] Other (specify)...[]
Do they ever use the Solar System when they study or do homework?	Always [4] Sometimes [2] Never [1]
Has the Solar system extended the hours used for reading/studying?	Yes [1] No [2]

Expectations and perceptions of Solar Home System

Which appliances did you expect to use when you got the Solar System?	
Are you satisfied or dissatisfied with the appliances you can use with the Solar System?	Satisfied [1] Dissatisfied [2]
Why do you feel this way?	
Has the Solar System changed your lives at all?	Yes [1] No [2]
IF IT HAS CHANGED THEIR LIVES, what are the most important changes? POSITIVE OR/AND NEGATIVE	
What do you like most about the Solar System?	

What do you dislike most about the Solar System?
Would you advise other people in the village and elsewhere to get a Solar System? Yes [1] No [2]
What are your reasons for saying this?

Income sources

USE THE FOLLOWING INFORMATION TO FILL IN THE TABLES ON INCOME

How much?		How often?	
Less than R200 – 1	R1800 to R2200 – 8	Every week – 1	Every 6 months – 7
R200 to R400 – 2	R2200 to R2600 – 9	Every month – 2	Once a year – 8
R400 to R600 – 3	R2600 to R3000 – 10	Twice a month - 3	Once in two years – 9
R600 to R800 – 4	R3000 to R4000 – 11	Every 2nd month – 4	
R800 to R1000 – 5	R4000 to R5000 – 12	Every 3rd month – 5	
R1000 to R1400 – 6	R5000 to R6000 – 13	Three times per year –6	
R1400 to R1800 – 7	More than R6000 – 14		

Are there any members of your household who earn a salary or wage?	Yes [1] No [2]
IF THERE ARE PEOPLE WHO EARN A SALARY/WAGE, FILL their names in TABLE 6 below, and answer the questions	

Table 6: Income from Household Members Earning Wages/Salaries

What is the name of the person earning a salary/wage? Use codes in Table1	How much money does this person contribute to your household? (choose from the options under 'How much')	How often does the person contribute to your household? (choose from the options under 'How often')
Example: S	4 (R600 to R800)	1 (every week)

Are there any members of your household who receive a pension (old age, disability) or child grant from the government? Yes [1] No [2]
IF THERE ARE PEOPLE WHO RECEIVE PENSIONS/GRANTS, FILL their names in TABLE 7 and answer the questions

Table 7: Income from Household Members Receiving Pensions Or Grants From The Government

What is the name of the person receiving a pension/grant? Use codes in Table 1	How much money does this person contribute to your household? (choose from the options under 'How much')	How often does the person contribute to your household? (choose from the options under 'How often')
Example: D	3 (R540 old-age pension)	1 (every week)

Are there any members of your household who have their own business (e.g. shop, welding business, bakery, shebeen)? Yes [1] No [2]
IF THERE ARE PEOPLE WITH THEIR OWN BUSINESS, FILL their names in TABLE 8 and answer the questions

Table 8: Income from Household Members with their own Businesses

What is the name of the person with his/her own business? Use codes in Table 1	How much money does this person contribute to your household? (choose from the options under 'How much')	How often does the person contribute to your household? (choose from the options under 'How often')
Example: SIL	6 (R1000 to R1400)	2 (every month)

Are there any family members or fathers of children who stay somewhere else and contribute money to your household? Yes [1] No [2]
IF YES, FILL their names in TABLE 9 and answer the questions

Table 9: Income from Other people who contribute money to the household

What is the name of the person receiving the money? Use codes in Table 1	How much money does this person contribute to your household? (choose from the options under 'How much')	How often does the person contribute to the household? (choose from the options under 'How often')
Example: GD	2 (R200 - R400)	2 (every month)

Are there household members who earn money by doing work for other people informally (piece jobs)? Yes [1] No [2]
IF YES, Ask the following questions:
What do they do to earn money?
How often do they get piece jobs (in general)? One or two days per week One or two days per month Other (specify) ....
More or less how much do they earn each time? (IN RAND)

Are there household members who earn money by selling things informally?	Yes [1] No [2]
IF YES, Ask the following questions:	
What do they sell?	
How often do they sell things?	Every day One or two days per week One or two days per month Other (specify)..
More or less how much money do they earn by selling? (FILL IN WHAT IS RELEVANT)	On one day .... In one week .... Every time they sell something ....
How often do they buy new materials or stock?	
More or less how much money do they use each time to buy new stock/materials?	
Do they make any of the things that they sell?	Yes [1] / No [2]

IF SOME PEOPLE IN THE HOUSEHOLD MAKE THINGS TO SELL, Ask the following questions:	
What is it that they make?	[]
Do they use any fuels when making it?	Yes [1] / No [2]
Which fuels do they use	Candles [ ] Gas [ ] Electricity [ ] Firewood [2] Paraffin [4] Coal [ ] Other (specify)..[]
Do they ever make these things in the evening or morning when it is still dark?	Always [4] Sometimes [2] Never [1]
IF THEY NEED LIGHT WHEN THEY MAKE THINGS, Do they ever use the Solar System?	Always [4] Sometimes [2] Never [1]

Do people in your household use all the money that is contributed (from wages, pensions, own business, etc), or must some of this money be sent to a person living somewhere else?	All of it is used by this household [1] Some of it is sent to another person/household [2]
IF SOME OF THE MONEY IS SENT TO A PERSON STAYING SOMEWHERE ELSE, Ask the following questions:	
What is the reason for contributing money to this other person/household?	Supporting a child [ ] Supporting a parent [ ] Other (specify) ....
How often do you send money to this person/household?	
More or less how much money is sent to this person/household each time?	

Table 1: Members of the household

Fill in the information about household members that are present and absent (no lodgers)

Name	Gender	Age	Relationship to household head	Highest level of education	Present or Absent (Living in the same household or not)	Employment status	Where does he/she live most of the time?	Number of own children
	Male – M Female – F		Husband – H Household head – HH Respondent - R Wife – W Son – S Daughter – D Son-in-law – SIL Daughter-in-law – DIL Granddaughter – GD Grandson – GS Other relative – R Not a relative – N Other – Specify	No schooling – N Grades – G1 to G2 Standards – S1to S10 Diploma – DIP Degree – DEG Other – Specify Std 10	Present – P Absent - A	Employed – E Unemployed – U Self-employed – Sel Housewife – H Student – Stu Child not at school – C Pensioner – P Disabled – D Other – Specify	Bizana – B Mt Ayliff – MtAy Mt Frere – MtF Flagstaff – F Mt Fletcher – MtFlet Matatiele – Mat Other – Specify	
Example: Priscilla	F	35	Respondent + GD		P	Self-employed	MtFlet	3
			Household head					
			Daughter					

Table 2: Household Solar appliances

Which appliances do they operate with the Solar System? (circle)	How many?	Working (w) or broken (b)?	When did they get it? – month, year	How did the household get it? - gift (g), hirepurchase (hp), laybye (lb), cash (c	How much did it cost (cash)?	How much are the monthly instalments (if applicable)?	Who paid/is paying for it?
Radio							
Radio/cassette player							
Hi-fi system							
Colour TV (small or big)							
Black and White TV (small or big)							
Cell phone battery charger							
Other:							